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International Marine Engineering

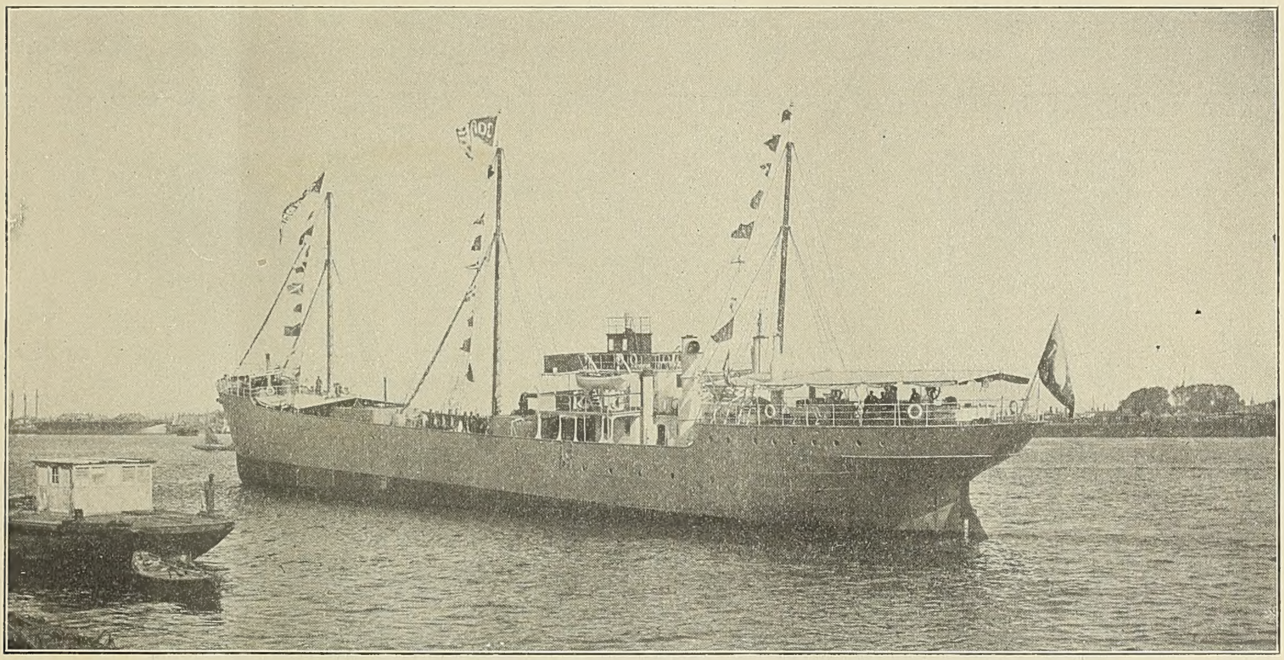
JANUARY, 1912

Large Russian Vessels Propelled by Diesel Engines

BY J. RENDELL WILSON

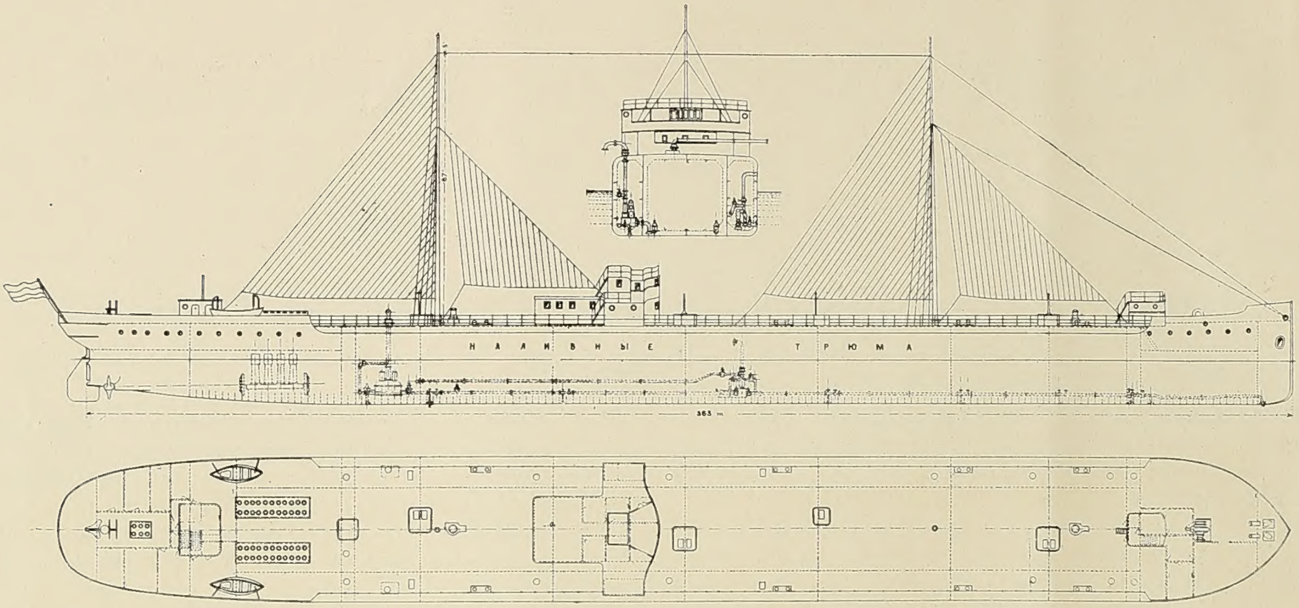
It has been considered by American and British shipbuilders, engineers and owners that Germany and other countries of Western Europe had recently made wonderful strides in the development of the big marine Diesel-type oil engine; and it was conceded by a few, including Lord Furness, that a revolution in the propulsion of shipping was not far distant. But it is almost startling to say now that in Russia this revolution is almost a thing of the past, and large Diesel vessels have been quietly in service since 1903, and at the present time internal-combustion engined ships of 5,000 tons are almost quite common objects. In INTERNATIONAL MARINE ENGINEERING of October I was enabled to give a complete resumé of the progress in Great Britain, Germany, Switzerland, Sweden, Italy, Denmark, France and the Netherlands, and on page 393 I referred to the fact that there were a number of big motor craft in service in Russia, but of reliable data I had very little. However, I am now able to give some very interesting examples of Russia's Diesel fleet. Altogether I have before me details of some forty vessels ranging from 200 tons to 5,000 tons loading capacity fitted with oil engines developing up to 1,200 horsepower per boat.

The development in the Near East is due to the enterprise of such ship owners as the Societé Anonyme pour L'Exploitation du Naphte Nobel Frères, of St. Petersburg; Messrs. Merkulew Bros., Messrs. Schmidt, The Lubimov Company, The Kuloaksky Mineral Works, The Caucasus & Mercury Co., and the Ministry of Communication. Credit is also due to the Russian Government, and to the Kolomnaer Maschinenfabrik Actien Gesellschaft, of Kolomna. The latter named have engined no fewer than nineteen Diesel ships, of which five were installed with motors of 1,000 to 1,200 horsepower each, and only two of the nineteen were under 300 horsepower. In addition the Kolomnaer Company are equipping five passenger, mail and cargo vessels with oil engines of 1,200 horsepower per boat, and all will be placed in service in 1911. They are being built to the order of the Caucasus & Mercury Company. The Maschinenfabrik Ludwig Nobel, of St. Petersburg, and the Nicolieff Engineering Company also have, I understand, constructed Diesel engines for naval and cargo vessels.



THE LATEST RUSSIAN DIESEL-ENGINED VESSEL, THE ZORASTER, A 2,000-TON PASSENGER AND CARGO SHIP EQUIPPED WITH TWO 500-HORSEPOWER DIESEL ENGINES

The firm of Nobel Bros., which must not be confused with Ludwig Nobel, placed their first Diesel ship, the *Wandal,* in service in 1903, and now possess a fleet of nineteen big motor craft, and are adding to these very rapidly. *Wandal* was a triple-screw boat of 800 tons loading capacity, 244½ feet long by 31 feet 9 inches beam, with 6 feet draft, and was driven by three triple-cylinder motors, each developing 120 horsepower at 240 revolutions per minute. At that time Diesel engines had not reached the reversing stage, so her triple propellers were driven through del Proposto electrical transmission gear. She has been a very successful vessel, and, I believe, is still running. During recent years new craft have,

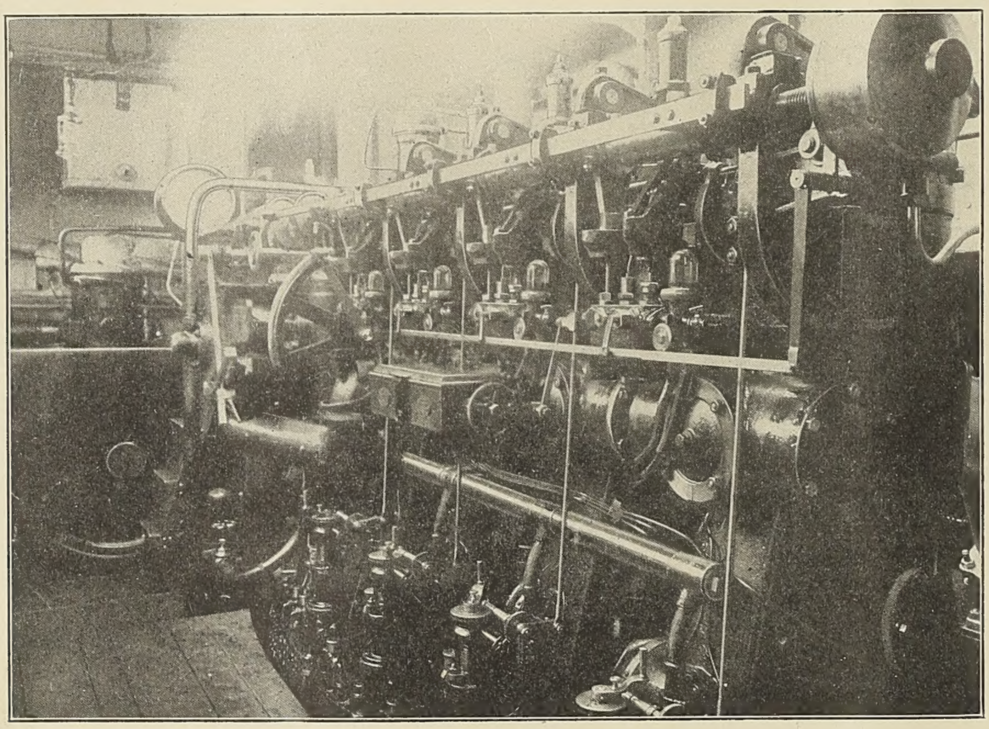


PROFILE AND ACCOMMODATION PLANS OF THE 4,800-TON DIESEL-ENGINED SHIP K. W. HAGELIN

of course, been equipped with reversible engines, so that no clutches or electrical gear is required with the later models.

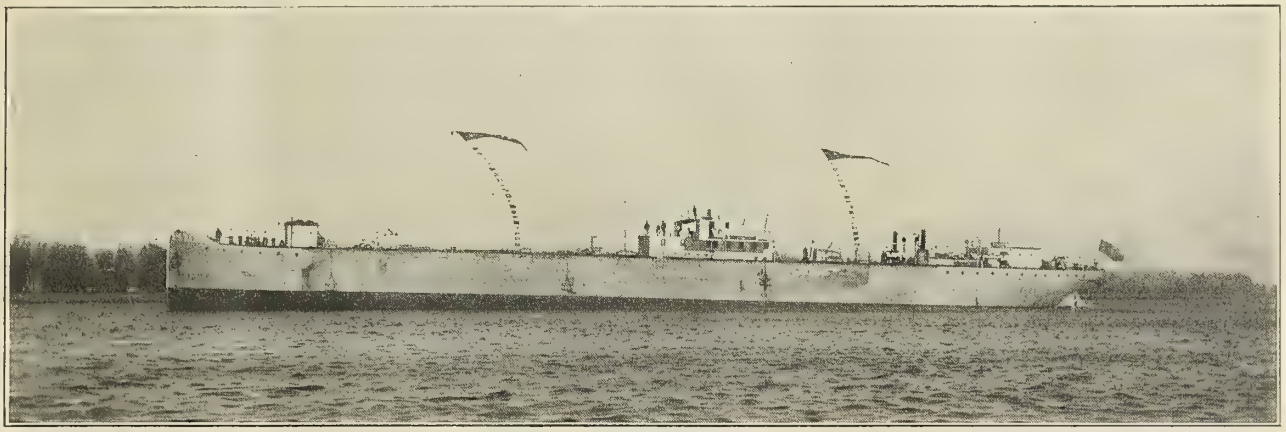
The illustration of *K. W. Hagelin* depicts one of the largest of Messrs. Nobel Bros. fleet. She is the sister ship to *Emmanuel Nobel,* so the following description corresponds: She is a twin-screw oil tanker, with a loading capacity of over 4,800 tons, and was launched in 1910, a year after *Emmanuel Nobel.* Her propelling machinery consists of two quadruple cylinder Kolomnaer engines, together developing 1,200 horsepower at 150 revolutions per minute, working, of course, on the Diesel principle. She is 380 feet in length by 46 feet beam, with a molded depth of 25 feet and 16 feet 6 inches draft, while her speed is 12 miles. She is engaged in the oil-carrying traffic on the Caspian Sea, and being funnelless has a very striking appearance.

Delo, of which an illustration is also given on the next page, is a tank ship of 4,000 tons loading capacity and 5,300 tons displacement, owned by Messrs. Merkulew Bros., and is in service on the River Volga. She is a twin-screw vessel, fitted with two quadruple-cylinder, 500-horsepower Kolomnaer Diesel engines, developing a total of 1,000 brake-horsepower, which give her a speed of a little over 11 miles an hour. The engine-room plan shows that on both the port and starboard side of the main engines there is a three-cylinder oil motor, which drives a compressor off the after end and a pump for emptying the main tanks at the forward end. By adopting this arrangement it is possible for all the starboard (or port) machinery to be broken down without affecting the working of the ship, except to reduce the speed or the rate of filling and emptying the tanks. Each auxiliary engine also drives a



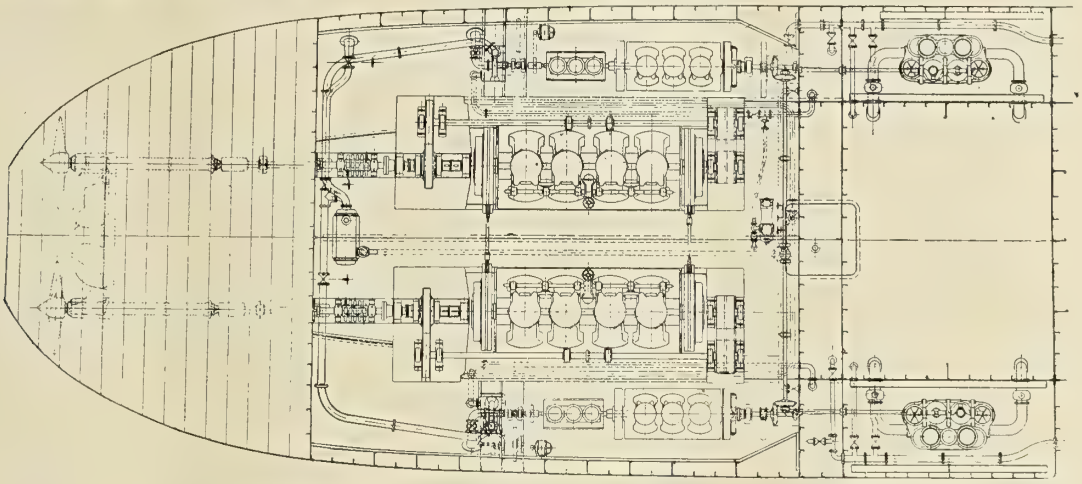
ENGINE ROOM OF TUG AND ICE-BREAKER JAKUT, SHOWING ONE OF THE TWO 160-HORSEPOWER POLAR-DIESEL ENGINES

small dynamo for lighting purposes. Reversing is carried out by means of a shaft running parallel with, and on the offside of, each main engine. At the forward end this shaft is driven in the reverse direction by intermediate gearing, and is connected to the propeller shaft by direct gearing. So it will be seen that when the clutch at the after end of the engine is thrown out of connection, the reversing shaft automatically comes into engagement. The drawing shows this clearly.



DELO, A 5,300-TON TANK SHIP FITTED WITH TWO 500-HORSEPOWER KOLOMNAER DIESEL ENGINES

It must not be thought that all these Russian Diesel ships are oil-tankers. *Gallilei* and *Zoraster,* two 1,000-horsepower craft of the Nobel fleet, are both passenger and ordinary cargo craft, and are handsome vessels, as commercial craft go. The illustration of *Zoraster* gives a good idea of what these two interesting boats are like. Both were launched in 1911, and are examples of up-to-date power craft. They are 270 feet long by 33 feet 4 inches beam, with 20 feet molded depth and 15 feet 6 inches draft. Each is fitted with two 500 brake-horsepower reversible Diesel engines, running at 200 revolutions per minute. Their net loading capacity is 2,000 tons apiece. Other motor vessels of Messrs. Nobel Bros. fleet are:



ENGINE-ROOM ARRANGEMENT OF THE DIESEL-ENGINED SHIP DELO

VESSEL	Tonnage and Capacity	Length	Horsepower	Date
Sarmat	800	244 ft.	360	1904
Belemor	160	110 ft. 6 ins.	140	1908
Kirgis	960	176 ft.	600	1908
Welikoross	1,280	188 ft.	800	1909
Maloross	1,280	188 ft.	800	1909
Jakut	400	105 ft.	320	1909
Samojed	350	132 ft. 9 ins.	280	1909
Robert Nobel...	1,760	260 ft.	700	1910
Kalmük	960	190 ft.	600	1910
Ostjak	480	190 ft.	400	1910
Lesgin	480	175 ft.	400	1910
Oestin	480	105 ft.	400	1910
Ingusch	208	140 ft.	200	1910
Masur	200	150 ft.	200	1911

The capacities vary greatly owing to the difference of beam and draft, which lack of space prevents my giving. All of these vessels are fitted with Diesel engines. The question, "Are Diesel ships profitable?" may be answered easily by the fact that the owners of this fleet have, I understand, paid an average dividend during the past five years of 15½ percent on a capital of $11,550,000 (£2,370,000). This capital is now being increased to $23,100,000 (£4,740,000).

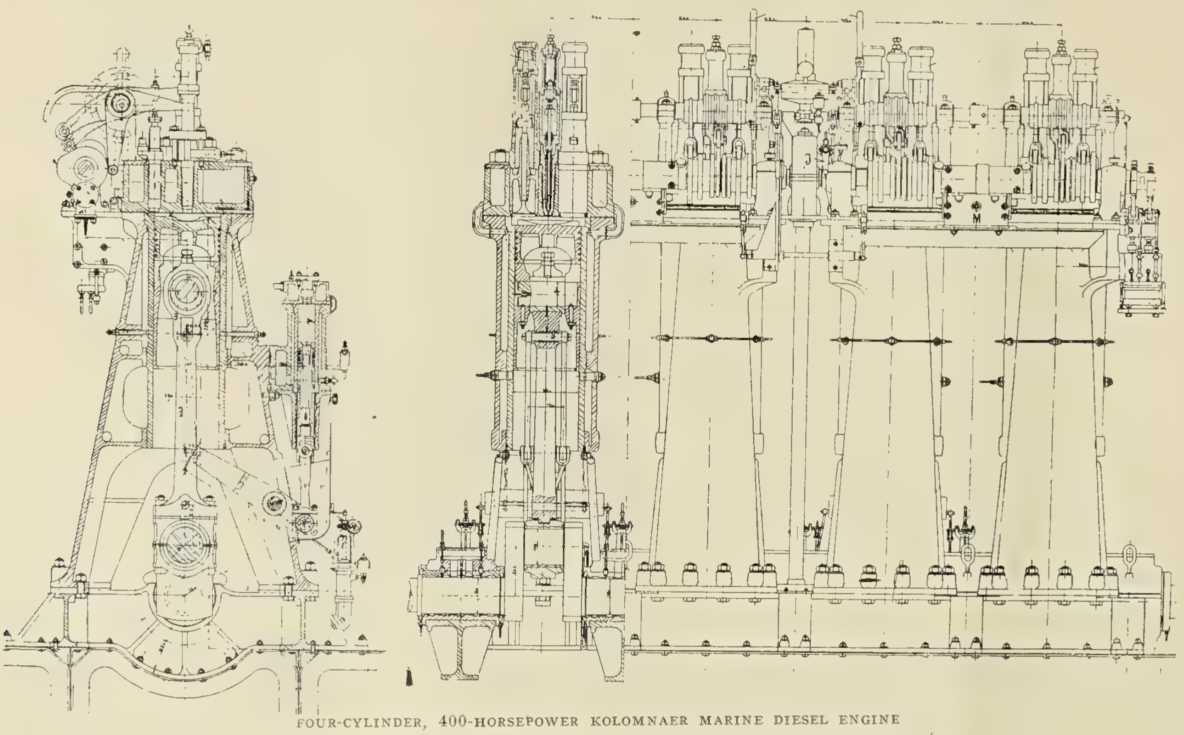
Among the Diesel ships owned by the other firms mentioned are the following: *Myssl,* a 300-horsepower Kolomnaer-engined tug on the Volga; that was placed in service in 1908. *Ilia Mirometz,* a 600-horsepower Kolomnaer-engined tug, also on the Volga, but launched the following year. *No.* 1 and *No.* 2, two passenger boats in service on the Volga, owned by the Ministry of Communication. *Karamish,* a 600-horsepower Kolomnaer-engined cargo vessel on the Volga. *Kolomna A* and *Kolomna B,* two 200-horsepower tugs running on the River Oka. (These two, by the way, are fitted with *horizontal* Kolomnaer marine oil engines.) *Passagirski I.,* an 800-horsepower Kolomnaer-engined cargo and passenger ship, running on the Kama and Volga Rivers.

Curiously enough over a dozen of the craft mentioned in the above two lists are large side paddle-wheelers, which accounts for horizontal engines being fitted in the two cases referred to above. The majority of the paddle-boats are designed as tugs, and on the River Volga they are used chiefly for towing huge tank-barges, some of which have a capacity of over 10,000 tons. To give an idea I may say that one of Messrs. Nobel's barges is 545 feet long over all by 72 feet 4 inches beam, with 11 feet 8 inches draft, and has a loading

capacity of 10,300 tons. The illustration of *Welikoross* shows clearly the type of motor paddle-boat in vogue. She is 188 feet long by 32 feet 6 inches beam and 3 feet 6 inches draft, and is fitted with two four-cylinder 400-horsepower Kolomnaer engines, turning at 200 revolutions per minute. The machinery is installed athwartships, with the paddle-wheel shaft between the two engines, and the drive is through reduction wheel gearing.

WELIKOROSS, AN 800-HORSEPOWER DIESEL-ENGINED RIVER TUG. MANY VESSELS OF THIS TYPE ARE IN SERVICE ON THE VOLGA

It is often said that naval authorities are slow to adopt new ideas, and only too true of some governments; but this can hardly be said of the Russian Admiralty, as far as heavy oil-consuming internal-combustion engines are concerned. I would respectfully draw the attention of the United States and British naval advisers to the fact that on the Volga and Caspian Sea, Diesel-engined gunboats (powerfully armed and heavily armored) of over 1,000 horsepower have been in service for several years. Those in service on the Volga are of the shallow draft, funnelless type, and are low-lying in appearance with large guns mounted in barbettes. Diesel engines of 1,200 horsepower are fitted.



FOUR-CYLINDER, 400-HORSEPOWER KOLOMNAER MARINE DIESEL ENGINE

The gunboats on the Caspian Sea are of a more seaworthy and robust type. At the present time the Société Anon. Chantiers Navals Atelier et Foundiers of Nicolieff are building a Russian revenue cruiser which is being equipped with a Diesel engine of 1,000 horsepower. It is also reported that the Russian Government is building an internal-combustion-engined battleship, which is well on the way to completion. This report, however, cannot be verified.

Naval Architects and Marine Engineers' Annual Meeting

In the previous issue were published abstracts of the first ten papers read at the nineteenth annual meeting of the American Society of Naval Architects and Marine Engineers recently held in New York. Following are abstracts of the remaining papers read at this meeting:

No. 11—Ship Calculations Derivation and Analysis of Methods

BY NAVAL CONSTRUCTOR T. G. ROBERTS, U. S. N.

ABSTRACT

This paper deals with the first elements of the subject of ship calculations, and might, therefore, seem unnecessary to present before naval architects, but it is expected that the treatment will interest those who may find in these notes a shorter or clearer method of teaching the subject comprehensively to the student. The methods of calculation discussed are those for displacement, center of gravity or curvilinear figure and waterline, center of buoyancy, center of gravity of bottom plating and moment of inertia and metacenter.

No. 12—Economy of the Use of Oil as Fuel for Harbor Vessels

BY ENGINEER-IN-CHIEF C. A. MC ALLISTER

ABSTRACT

Some very valuable data regarding the economy of the use of oil as fuel on board the harbor tug *Golden Gate*, doing revenue cutter boarding duty at San Francisco, Cal., are given in this paper. The data show that the investment paid over 100 percent in annual dividends in this particular instance. The essential details of the apparatus and the results obtained therefrom were published in an article on page 158 of the April, 1911, issue of INTERNATIONAL MARINE ENGINEERING.

No. 13—The Marine Terminal of the Grand Trunk Pacific Railway, Prince Rupert, British Columbia

BY FRANK E. KIRBY AND WILLIAM T. DONNELLY

ABSTRACT

The city of Prince Rupert is located on Kaien Island, which forms the right of the entrance and the southeast shore of Prince Rupert harbor. The city proper is laid out over an area 3½ miles in length by 1 mile in breadth, on the shore of the island, with a background rising to an elevation of from 1,600 to 2,000 feet, the general characteristics reminding one very forcibly of the city of Montreal with Mount Royal behind it. The Grand Trunk Pacific Railway will reach the coast by the Skeena River Valley, about 15 miles to the south, and crossing to Kaien Island at its southern end, will closely follow the shore to and along the water front of Prince Rupert. The general character of the shore of Prince Rupert is bold and rocky, falling off very rapidly to a depth of approximately 20 fathoms. A careful examination of the entire length of the harbor front of Kaien Island determined Hays Cove as the only practical place for such a development as was contemplated; that is, a floating drydock of 20,000 tons lifting capacity, so designed as to be capable of operating in sections as a number of smaller docks, an adequate shore plant comprising electric power generating plant with air compressors, machine shop, boiler and blacksmith shop and covered construction shed under which the pontoons of the floating drydock could be built. The dock is to be of such a design and construction as to be almost entirely built upon the site. To accomplish this the general plan provides for the practical completion and equipment of the shore plant before the dry-dock is commenced. One of the controlling features in the general plan of this development was the fact that the city of Prince Rupert will be 600 miles from the nearest base of supply or point where any considerable assistance, mechanical or otherwise, can be obtained. It was therefore determined at the outset that the mechanical equipment, large tools, etc., must be of the very best and most complete. Also, that on account of the high price of labor on the Pacific Coast, ample provision for the use of power in every way possible should be made. This has resulted in the design of an electric power generating station with ample capacity for all present needs and with a large possibility of extension.

The first work to be undertaken will be the pier. This will be 420 feet in length and 60 feet in width, the piling being on 10 by 5-foot centers. The pier will require about 600 piles. At the same time there will be built the platform at the shore end of this pier, 80 feet wide by 930 feet long, having an area of 74,400 square feet, and will require about 1,600 piles on 5 by 10-foot centers. At the western end of this platform there will be an extension off shore 350 feet long by about 100 feet wide, and at right angles to this an extension 560 feet long by 80 feet wide for the attachment of the floating dry-dock. In front of the main platform, east of the pier, there will be built a launching platform for side launching. This will be 80 feet wide by 440 feet long, and will be carried on 16-inch piles on 5 by 10-foot centers, braced and reinforced by heavy piling along the edge over which the launching will take place.

Electric power is to be furnished for operating the pumping machinery of the floating dry-dock, for compressing air and to operate machinery in the various shops, also for furnishing electric lighting for the plant. The building for the power plant is to contain both boilers and power plant under one roof with fireproof dividing walls, and is to be 104 feet wide by 148 feet long, having a covered area of 15,392 square feet. The building will be of modern steel-frame construction, the walls and roof to be of reinforced concrete. There will be installed six 400-horsepower watertube boilers, supplied with automatic stokers, chain-grate type. Provision is made for adding two extra boilers. There is also a provision for the installation of an economizer, in case it is found that the load factor warrants the expense. Draft will be obtained by a steel or concrete chimney 175 feet high and 11 feet in diameter. An overhead trolley is provided for handling coal from storage to hoppers above the stokers and also for handling ashes. Provision is made for receiving coal both by water and rail. Coal by water will be received at the outer end of the pier, for the unloading of which there is provided a standard grab-bucket installation, so arranged as to load cars beneath the hoppers, the cars to be handled by small yard locomotives to the coal pocket of 1,000 tons capacity, located adjacent to the boiler house. Coal received by rail will be delivered direct from the cars of the Grand Trunk Pacific Railway, which pass at the rear of the property to the coal pocket approached by an incline. There will be two main engines of 900 horsepower each, and while vertical reciprocating compound engines are specified, using steam at 175 pounds pressure and 258 revolutions per minute, turbine engines will be considered as an alternate. Jet condensers are shown, but alternate figures will be taken for surface condensers.

Electric generators are to have a capacity of 600 kilowatts, three-phase, 25-cycle, 550-volt alternating current. For these

generators there will be provided two steam-driven exciters, one of 50 kilowatts and one of 25 kilowatts capacity. These machines are to be direct current, 220 volts. There is also to be a motor-driven exciter of 25 kilowatts capacity, the motor for this machine to be a 35-horsepower, three-phase, 25-cycle, 550-volt alternating-current squirrel-cage-type motor. The entire system of light and power throughout the plant is to be controlled from the switchboard located on the main floor of the power house. There will be provided for the erection of this machinery in the power plant a 15-ton overhead traveling crane. This will be operated by electricity, and the current supplied will be from one of the steam-driven exciter sets. For furnishing compressed air to the shops of the plant there will be provided a compound Corliss air compressor having a displacement of 1,580 cubic feet of free air per minute when operating at 150 revolutions. This compressor is to be designed for a steam pressure of 175 pounds per square inch and for an air pressure of 100 pounds. The distribution of the air will be by means of underground piping through the yard.

The combined boiler and blacksmith shop is to be 76 feet wide by 150 feet long, the central part to be 33 feet wide, provided with a 15-ton traveling crane. The design is of the usual steel-frame shop construction, and will, in this instance, be covered with wood. The flooring will be of concrete with heavy foundations for the large tools. The tool equipment will be very complete, comprising heavy punch and shears, rolls, plate planer, flanging clamps, etc., heavy steam hammer and a full equipment of blacksmiths' tools. The building for the machine shop will be constructed from the same set of plans as the boiler and blacksmith shop. The flooring will be of concrete with special foundations for large tools. Ample provision is made for thorough lighting, and the building will be steam-heated throughout. A very complete equipment of machine tools will be provided, comprising all machinery necessary to handle the heaviest crank and other shafting of large steamers; also boring, drilling and turning machinery for repairing all the secondary machine equipment of steamships. Large tools will be driven by individual motors, the smaller tools being arranged for group driving. A 15-ton overhead traveling crane will be provided for both boiler and machine shop.

On account of the work of building the pontoons for the floating drydock and the possibility of shipbuilding in the future, a building shed and woodworking shop were designed. The shipbuilding portion of the structure is designed to have a covered width of 86 feet by 300 feet long, with a clear height under cranes of 50 feet and under girders of 56 feet. The shop section of this building is to have a width of 80 feet and a length of 300 feet. The ground floor will be used for machinery and the upper floor will be used as a laying-out floor.

There will be an office and administration building, 40 feet wide by 100 feet long, constructed of wood, two and one-half stories high. This will be fitted up with drafting room, accounting and bookkeeping department and private offices.

The 20,000-ton pontoon floating drydock is to be almost entirely constructed at and by the plant of which it is to be the principal feature. This dock is to have an over-all length on keel blocks of 604 feet 4 inches, a clear width of 100 feet and a width over all of 130 feet. The lifting power is the aggregate of twelve pontoons, of timber construction, each 130 feet long, corresponding to the width of the dock, 44 feet wide in a direction corresponding to the length of the dock, and 15 feet deep. These pontoons are to be united by steel side walls or wings, 38 feet high, 15 feet wide at the bottom and 10 feet wide at the top, the walls being divided so that the whole structure may be used under ordinary conditions as three separate docks, one of six pontoons, with an over-all length of 269 feet, and two of three pontoons each, with an over-all length of 164 feet each. The largest commercial ship upon the Pacific Coast at the present time is the *Minnesota*. This vessel would have a dead weight in ordinary unloaded condition of approximately 18,000 tons. The machinery for pumping the dock will consist of centrifugal pumps operated by electric motors, the capacity of the equipment being sufficient to pump the entire lifting power of the dock in less than two hours. The structure as a whole is secured to the shore by the engagement of clamps on the dock, with a vertical truss secured to the pile platform or pier in such a way that it is free to rise and fall with the tide, and when being raised or lowered with a ship. The location of these attachments is such that when it is desired to use the dock in three separate sections, the bow section may be detached and moved around the corner of the pier work located as shown on the general plan alongside the platform, and secured in the same manner as provided for in its original position. To make the other two sections available as separate docks, it is only necessary to detach the middle section, comprising six pontoons, from the pier work and advance it the length of the detached section, when the sliding clamps upon the wings will coincide with those used for the previous section when the dock was operated as a whole. This will allow ample space between the center and stern sections for the overhang without interference of vessels which may be docked on them. As the feature of a sectional dock to be used as a whole or separately is somewhat new, it is desired to call attention to the fact that the three largest commercial docks in the United States, namely, the 10,000-ton floating drydock of the Tietjen & Lang Dry Dock Company, built in 1900; the 12,000-ton dock of the Morse Dry Dock Company, built in 1902 (both in New York harbor), and the 10,000-ton dock of the Port of Portland, Portland, Ore., are sectional docks in five sections each. All of these docks are of timber construction and are giving excellent service.

No. 14—Cargo Transference at Steamship Terminals

BY H. MC L. HARDING

Abstract

The purpose of this paper is to indicate the importance of terminals in water transportation, and to show the feasibility of increasing the rapidity of freight movements, of reducing the handling costs, and of increasing the capacity of existing terminals by the adaptation of improved mechanical methods. The figures and data contained in this paper are confined to miscellaneous package freight, excluding bulk freight, and mainly refer to export, import and coastwise traffic. The points covered by the paper are the present movements at terminals of miscellaneous freight, both outbound and inbound, with special reference to the different classes of package freight; the usual methods of handling cargoes to and from ships, lighters, drays and cars; a description of the different kinds of freight transferring machinery, with the details of the mechanism and comparative costs; conditions to be fulfilled by any machinery, and the latest adaptation of different kinds of standard machinery to the freight movements, with a statement of capacity and rapidity of loading and discharging; installation costs of such machinery, including interest and amortization; the cost of operation with maintenance and comparison with manual cost. In summing up the advantages of mechanical methods of package freight movements, of which the most important is the lifting or hoisting, the author comes to the following conclusions: 1. Greater rapidity in lifting, discharging and distributing; the delay of transference can be reduced by one-half in comparison with manual labor. 2. Economy per ton handled; a saving effected of at least one-half. 3. Increased holding or storage capacity at piers. 4. Greater working capacity at each pier. 5. Less port detention, meaning fewer ships to

transport a given tonnage. 6. Saving in port investment. 7. Improved dray service and reduction in damage claims from breakage. 8. A larger return from the money invested in cargo transferring machinery than from any other element of a transportation system. This paper will be published in detail in a future issue of International Marine Engineering.

No. 15—Heavy Oil Engines for Marine Propulsion

BY G. C. DAVISON

Abstract

The Diesel cycle is briefly described and compared with the Otto cycle, and then the relative advantages of four-cycle and two-cycle marine engines are summed up, whereby it is shown that the economy of the four-cycle type results in about 8 or 10 percent less fuel consumption than the two-cycle engine, but with other conditions, such as heat conditions, turning moment, reversibility, weight and space, the advantages lie mainly with the two-cycle engine for marine work. One of the most important parts of the paper is the discussion of mechanical problems connected with heavy oil engines. Here materials, piston speeds, lubrication, piston packing and stuffing-boxes are duly considered. In summing up, the author states that the only problems which have had to be solved are those due to the high-pressure and temperature in the cylinders. From the results thereby obtained it would appear that these practical problems are easily and cheaply solved, whereas it has taken many years of extensive experimental work by manufacturers to investigate and solve these problems. The author shows to what extent oil engines are being used for marine purposes, and the advantages of its use are explained in detail, including economy of fuel, attendance, weight, space, endurance, repairs, reliability, absence of smoke, funnels, cleanliness, readiness for action and time for loading fuel. A proposed installation for a typical high-powered, coal-burning destroyer is also described to show by comparison the advantages of the heavy oil engine.

No. 16—Automatic Record of Propeller Action in an Electrically Propelled Vessel

BY W. L. R. EMMET

Abstract

In studying the problems connected with electric ship propulsion, the author has encountered some contradictions and differences of opinion concerning the conditions necessary for satisfactory reversal. The discussion of these matters and the lack of definite information which has been discovered has led to the making of the experiments which are here recorded, and although the case is not a representative one, the data being definite and certain have some engineering interest as a basis of comparison.

The fireboat *Graeme Stewart* is one of two boats owned by the city of Chicago. (See International Marine Engineering, September, 1908, December, 1908, and January, 1909.) They are equipped with General Electric turbines which drive centrifugal fire pumps. These turbines are also connected to direct-current generators, and each of the twin-screw propellers is driven by a motor. The fields of these motors are separately energized from a constant potential exciting generator, and speed changes are accomplished by changing or reversing the field excitation of the generators.

The automatic record of conditions shown by the curve sheets accompanying the paper was taken by recording ammeters. With this instrument the record of current variations is drawn upon a strip of paper, and arrangements are made by which records of equal time intervals and of propeller revolutions are marked upon the same record. In addition to these records, which are easily provided for, a propeller log was rigged on an outrigger near the bow of the boat and connected through an electric circuit in such a manner that a mark was made upon the record strip every time the propeller made a revolution. The log was calibrated by repeated runs over established distances on the Chicago water front. From the results of this calibration the speed of the vessel through the water can be accurately determined from the marks on the paper down to a speed of about 150 feet per minute.

These automatic records show a rather irregular line for the current record. The current was regulated by the use of the field rheostat of the generator and a dead-beat ammeter in the pilot house, and the average result of the variable currents shown by records is very close to that shown by the curves.

From the records taken directly from these instruments other curves have been made showing the variation of speed to power, slip and average revolutions per minute of the two propellers, and also a curve showing the relation between the torque and the time required to stop the vessel.

In considering the reversal conditions shown by these tests, the propeller characteristics as shown by the slip curve should be borne in mind. The maximum speed which the vessel is capable of making is 11 miles per hour, and at this speed the slip is nearly 19 percent, while at 5 miles per hour it is only 9 percent. This increase of slip at higher speeds indicates that the propeller is of insufficient size, and this deficiency must tend to diminish the value of high torque in reversal.

No. 17—Some Applications of the Principles of Naval Architecture to Aeronautics

BY NAVAL CONSTRUCTOR WILLIAM MC ENTEE, U. S. N.

Abstract

Considering the essential similarity of the problems involved in aeronautics and in naval architecture, it is a singular fact that with the development of the first, both theoretically and experimentally, but little has been done by the trained naval architect. There is no doubt that many difficulties could have been avoided by the earlier experimenters and many practical advantages can be gained to-day by those engaged in aeronautical engineering through the use of some of the fundamental principles of naval architecture. As in naval architecture, the practical elements dealt with in aeronautics are: Weight or displacement, buoyancy, stability, resistance, propulsion and speed. For higher theoretical investigations the mathematics of stream lines or fluid motion are equally applicable to each. At the present time the aeroplane appears to promise greater returns in usefulness, and in any case its development has recently been so rapid that it attracts more interest than does the dirigible. For this reason the discussion in this paper is limited to aeroplanes and deals only with questions of stability and propulsion. The paper will be published in detail in a future issue of International Marine Engineering.

Presentation of the John Fritz Medal

One of the most notable features of the meeting was the presentation of the John Fritz medal to the society's distinguished honorary member, Sir William Henry White, which occurred at the annual banquet which was held in the Grand Ball Room of the Waldorf-Astoria on the evening of Nov. 17. The presentation of the medal was by Mr. Onward Bates, of the John Fritz Medal Board of Award. John Fritz was also present, and responded most fittingly to Sir William's acceptance. The other speakers included Hon. George von L. Meyer, secretary of the United States navy; the president of the society, Mr. Stevenson Taylor, acting as toastmaster.

Marine Gas Engines: Their Design and Application—V

BY E. N. PERCY

(Continued from page 489, Vol. XVI.)

If the engine be provided with a governor of the throttle type, at low speeds there will be a weak mixture above the governor and a much denser mixture below the governor for the same reasons. If the governor opens instantly the same action takes place as before, and the engine stops when taking on a heavy load, the engine having speeded up somewhat with the mixture already in the cylinders and pipe, and this robs the pipe above the governor of its rich mixture. During this time the mixture below the governor has been weakened by condensation and wire-drawing through the governor, and this provides the engine with a mixture too weak to run. This mixture seldom backfires, even though weak, because cut off by the governor.

The proper arrangement for overcoming these various objections is as follows: the object being to allow the carburetor to operate under as uniform conditions as possible, no matter what the engine is doing and no matter how quickly the conditions in the engine may be changed, the conditions in the carburetor should change as slowly as possible, the first requirement being a mixture velocity of about 5,000 feet per minute in gas pipe, same to be designed for minimum speed of engine. Above the engine inlet valves should be large chambers, and the branch pipes leading from the manifold pipes to the branch pipes much larger than the manifold pipes if possible. Near each branch pipe or inlet valve should be an auxiliary air pipe. In this pipe is a spring check valve with the spring so adjusted as to allow the valve to open in proportion to the speed of the engine in such a manner as to maintain a mixture velocity of 5,000 feet for minimum speed and a slowly increasing velocity, to no more than 7,000 feet, for maximum speed in order that the mixture pipe may be filled with a somewhat richer mixture for the higher speeds to make up for the purer air taken in through the auxiliary air valve. This system has been found to work perfectly in practice, particularly when used in connection with a positive-action carburetor delivering a definite quantity of fuel for each suction stroke of each cylinder. This arrangement is used substantially as described by one firm, and it has been found that the engine will run at the lowest speeds, or at the highest velocities, with equal ease, and may be instantly changed from one to the other without chocking, missing, back-firing or other symptoms of distress, provided a good carburetor is used.

When the mixture is too rich it is easily noticed in one of several ways, partly by the smoking in exhaust pipe; but as this sometimes also comes from too much lubrication oil it should be carefully regarded, as the lubricating mixture gives a blue smoke and the over-rich mixture gives a heavy black. Also with the over-rich mixture there is a tendency to miss fire, consequently as the exhaust becomes very hot, and if the exhaust opening is near enough to the engine, flame appears with every stroke. The reason for this is that there is so much mixture to burn in insufficient air in the cylinder that it must complete burning in the exhaust pipe. If the mixture is too weak it may be always and positively known by its back-firing into the carburetor, flame frequently issuing from the air valve into the carburetor, the reason being that as a weak mixture is slow burning, and frequently is still burning after the exhaust valve has closed, it ignites the incoming charge, which on account of its plentiful supply of air extends the ignition back to and through the carburetor, a thing which could not occur with the rich mixture on account of the insufficiency of air and of the great cooling action of a rich mixture on the flame.

It should be noted here that gas engines are opposite to liquid-fuel engines or hydrocarbon engines, in this respect, that if a gas engine has too rich a mixture it will back-fire into the exhaust valve, etc., whereas if the mixture becomes too weak it will fire into the exhaust pipe; the reasons of this are that the weak mixture, being plentiful in air, will miss when the two explosions cool in exhaust pipe and then be exploded by the flame of the next explosion, while rich mixture, not being cooled by vaporization as with liquid fuel, and being intimately mixed and extremely inflammable and usually in conjunction with large ports and valves, also being slow burning and frequently still burning after the exhaust valve has closed and the inlet valves open, back-fires with the greatest ease.

In connection with smoke in exhaust pipe it should be noted that when the carburetor is placed too near the engine or in very cold weather, when the fuel does not vaporize but is carried into the engine in a suspended state, the exhaust will smoke because of imperfect combustion. Hence it is important that the carburetor should be placed at a proper distance from the engine, the pipes made of the proper sizes and the auxiliary air valves placed on the engine near the inlet valve if the engine is to be of the variable speed type, or may be placed on or near the carburetor if the engine is of the constant-speed type for turning generators, etc.

It is not possible for any suction jet carburetor to deliver fuel in proportion to the amount of air used, for the reason that as the amount of air used varies so does the rarefication vary in the suction throat, and the laws governing the flow of fluids through an orifice are subject to a large variation. Friction, as in a needle valve, does not vary in the same proportion as the laws which govern the rarefication of a given amount of gas passing through a constricted orifice. This may be easily investigated and proved with complicated formulæ by those who care to take the trouble.

The ideal carburetor will measure a definite quantity of fuel for each stroke of the engine; this quantity to be varied by definite action by the governor, only such minute quantities of fluid are extremely hard to measure accurately, and it is doubtful if it can be done at all in single strokes, but by having the carburetor deliver sufficient for three or four piston displacements, or even more, and then having this measured amount passed through a spray nozzle, perhaps practical results may be reached.

Carburetors for alcohol, kerosene (paraffin) and heavy distillates require jacketing, because these fuels are not vaporized at atmospheric temperatures. With alcohol it should be remembered that shellaced cork floats cannot be used, as the alcohol destroys the shellac and disintegrates the cork.

The temperature of hot jackets must be carefully adjusted for the fuel, because if too hot the carbon residue is left, and if too cold only the lighter and more volatile parts of the fuel are used. With alcohol it is sufficient to have the carburetor at the heat of boiling water; in other words, the carburetor may be jacketed with heated water from the engine jacket. Alcohol may even be used in an ordinary carburetor, provided the carburetor be first started by gasoline (petrol), but in this case the alcohol has not been carbureted but is merely in suspension in the air. To make the best use of alcohol the inlet pipes, valves and carburetor should be jacketed with hot water.

In the case of kerosene (paraffin) it is necessary to have a

very much hotter carburetor. This does not mean a red-hot plate or retort which involves actual chemical changes, but a carburetor and inlet pipes which are jacketed with hot gas from the exhaust and which have been found to give very good results, otherwise it is entirely a matter of adjustment, as with any other carburetor.

With the heavy distillates it is better to merely jacket the carburetor and use highly-heated air for carburetion. The reason is that if the distillates be heated by anything much over 400 or 500 degrees F. they split up and deposit carbons and tars, whereas kerosene does not exhibit such tendencies.

The temperature of air used for carburetion is an important matter; if atmospheric air be used with any of the fuels in question it may frequently be noticed that the carburetors and inlet pipes are covered with frost or dew. In such a case there is very apt to be imperfect carburetion, because the temperature is so reduced by vaporization that the remainder of the fuel is carried in suspension or condensed on the sides of the inlet pipe. In practical tests it has been found that the engine is very apt to smoke on account of unburnt fuel, even though the mixture be comparatively weak, when the carburetor is running very cool, and for this reason it is very usual to supply the carburetor with heated air.

According to the condition, fuel used, etc., it is usual to heat this air to all degrees varying from merely warm air, taken from the vicinity of the engine, to highly heated air, taken from the lower part of the cylinders or a special exhaust heater, depending largely on the fuel used and the temperature obtained. The best results seem to be obtained when the temperature of the incoming air is such that the carburetor and pipes do not collect frost and very little dew or outside condensation.

Many methods have been provided for starting carburetors with fuel requiring greater temperature than the atmosphere for vaporization, some having torches, some special attachments; but the most general and practical method is to operate the engine with gasoline (petrol), either from the same carburetor or from another carburetor, until everything is warmed up. This method causes loss, but nevertheless involves less risk than any other in present use.

The injection of water by means of a water carburetor in connection with the heavy distillates is a very necessary factor. This action is not fully understood and can only be speculated upon. But it is known that heavier distillates may be burned in connection with it; that the engines run cleaner; that higher compression may be employed on account of its cooling action, and that the engines in general run a little cooler.

For the heaviest distillates and crude oil, there have been many inventions made which intended to utilize same in gas engines. All of them, so far as is known (and some thousands of patents have been taken out), may be reduced to one principle: a retort externally heated, usually by the exhaust heat of the engine; a place to put the oil in, another place to take the gas out and the usual means for removing the residue.

The principal feature which militates against their success is fractional distillation; that is to say, instead of making a permanent gas they have distilled the vapors at various temperatures, which makes a condensible vapor, and its products do not only include lighter hydrocarbon but also heavy tars, gums, etc., which vaporize in distilling at low temperatures and play havoc with the engine. As these products are entirely distillates or vapors and not permanent gases, any attempt to wash or scrub them would leave little, if anything, for the engine, and the quantity of residue in the retort is so great as to render it mechanically inefficient in a short time. All the vaporous retorts are either unmechanical or all those which work well mechanically fail in the following important respects:

In the first place, the oil should be filtered in order to remove foreign substances and the heavier clotted hydrocarbon, so that they will not enter the retort at all. Next the oil, before being treated by any other process, should be cracked; that is to say, it should be vaporized, the vapors condensed against a cold cover and allowed to drop back into the oil bed, which process reduces the oil to a fine consistency and a more simple series of hydrocarbons. By referring to a previous statement it will be noted that temperatures of 1,000 degrees to 2,000 degrees are necessary to effect chemical combinations of the various hydrocarbon series and make stable gases.

In calculating the latent heat of oil, together with the temperature, the amount of heat necessary to effect chemical combination in making stable gases, it may be generally accepted that the exhaust heat of the engine is entirely inadequate to make stable gases from any kind of oil. Therefore there should be another source of heat, possibly the oil flame, the heat of the exhaust being used merely for preliminary purposes, possibly the cracking of the oil. Furthermore, as it is probable in any event that there will be residue and tar, perhaps both could be burned externally and furnish this source of heat. On account of the large proportion of carbon in these series there is an obvious necessity of additional oxygen and hydrogen to assist in the making of any stable gas. This may be supplied by the addition of steam or water in some part of the process.

Such processes have often been successful in the actual making of a stable gas, as, for instance, directing an oil spray against white-hot material in conjunction with steam; the leading of lighter vapors and steam into a white-hot retort, or retort heated to 600 degrees C. externally. So much lampblack and other by-products are ejected as to render the process too expensive for gas engines in a general way, although it is used at present in a number of instances for want of a better method. This class of work, however, is not to be treated with carburetors and belongs more properly to gas producers, and is taken up in that chapter.

Cylinders, Heads, Valves and Pistons

Material—Nothing about the gas engine involves such careful design and workmanship as the cylinder and its auxiliaries, because of the great pressures, high temperatures, sudden shocks, unequal expansion and wide differences in temperature of the parts. Therefore the designer is called upon to meet many most difficult conditions. Because of these same things mechanical work is rendered much more complicated. Instead of making parts to merely fit each other, actual allowances must be made for differences in temperature, and careful consideration must be given to the condition of each mechanical part under operative conditions.

Cast iron is the most widely used material for gas-engine cylinders, most cylinders being cast integral with jacket. Some of the engines made of this material include extremely high-speed engines of light construction for automobiles, motor boats and air ships, having cylinders constructed of special alloys, containing percentages of aluminum, nickel and other constituents. Cylinders have also been made with simple steel tops, bushed with cast iron.

In very large engines cast steel is frequently used, the main object being to get the greatest strength for the least possible design, but owing to the great factor of expansion of steel with varying temperatures, great care should be exercised in the use of same.

Design—There is much discussion as to whether the heads should be cast integral with the cylinders or separately and bolted on. It is advisable largely to make the engine with the heads cast integral, and it is perfectly admissible if small enough so that the cylinder may be removed easily. But even this is risky, as frequently the cylinder is not replaced exactly in line. It is probable that small engines are better off

with heads cast integral, and large engines, say cylinders more than 5 inches in diameter, should have separate heads.

Certain points should be observed to make separate heads successful in every way. First, gasket should be used and no water should pass through gasket, all water connections being made by outside fittings. Ground joints are used with great success, provided the head is never removed except by skilled workmanship, but such a head requires valves mounted in cages for removable ignitors and piston removable through the lower end of the cylinder, so that the head need be removed very seldom, if ever. Hence the ground joint may be assumed as satisfactory in the hands of highly skilled workmen and not suitable for mercantile engines, which are liable to be repaired by workmen of moderate skill and put together in an unclean condition.

Owing to the high-pressures and temperatures and small density of the gases, especially in the case of long-stroke, slow-running engines, serious losses may be experienced by leakage through the hot joints. A very successful method of overcoming this is to extend the head a considerable distance down on the cylinder; in fact, practically dividing the cylinder into two halves, one-half of which forms the head, thereby removing the joint from the point of pressure to a point just level to the top of the piston at the end of the stroke. In this case neither gasket nor ground joint is needed, merely a good mechanical joint.

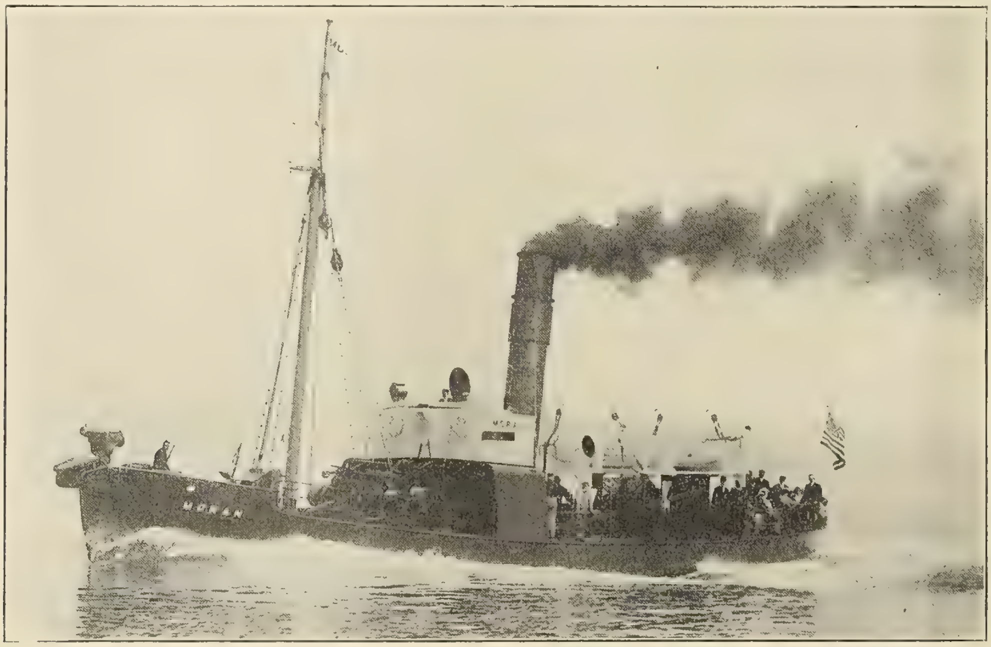
The methods of making ground joints are well known to all first-class designers, the only special point with the gas engine being that they should be so located that they might run as cold as possible. Many successful gas-engine gaskets are offered by the trade in asbestos compounds with wire mesh, asbestos compounds with cloth mesh, copper, copper-enclosing asbestos, corrugated copper with corrugations filled with asbestos usidurian.

The coefficients of expansion for the various methods can be found in any engineering work, and by applying them first to the internal wall of the cylinder, running at a temperature of 600 degrees to 1,200 degrees, depending upon the conditions, and then to the outer jacket, running them 60 degrees to 160 degrees, one can readily ascertain if a dangerous difference of expansion exists and if the end webs are subject to dangerous stresses.

Provision for lubrication, so far as the cylinder is concerned, consists merely of passages through the jacket, by means of which the oil may reach the proper point on the piston. It is customary with most designers to allow the bore and counterbore to be so arranged that the piston ring tips each at the top and bottom. This is a refinement entirely theoretical and not borne out by practice. With the least change in adjustment of brasses one of the rings is liable to turn over, if not wreck the engine; unless the case is cast integral it is possible to get the upper ring in the counterbore so that the piston may never be removed without breaking it. An engine in which the counterbore extends from a little above the top of the piston at the end of its stroke to a little below the lower end of the piston at the lower end of its stroke is found to give perfect service in practice, regardless of the piston and the rings.

Off-set cranks have been the subject of much discussion in relation to pressure and wear on the cylinder. In a very able paper on this subject an eminent authority states that when the various elements are carefully considered, including inertia, velocity, etc., that off-setting of the cranks has very little effect one way or the other upon cylinder wear or pressure, but that it does improve lubrication slightly, and has other advantages which will be discussed in connection with pistons but does not relate to cylinder pressure. The thermal cycle is also somewhat improved, because the outgoing stroke is longer than the return, off-setting of the crank giving a quick return motion.

(*To be concluded*)



A 96-FOOT STEEL STEAM WHALER BUILT ON THE PACIFIC COAST

Steam Whaling Vessels

The Moran Company, Seattle, Wash., during the present year built and delivered to the American Pacific Whaling Company, Aberdeen, Wash., two steel whale hunting vessels of the following general dimensions:

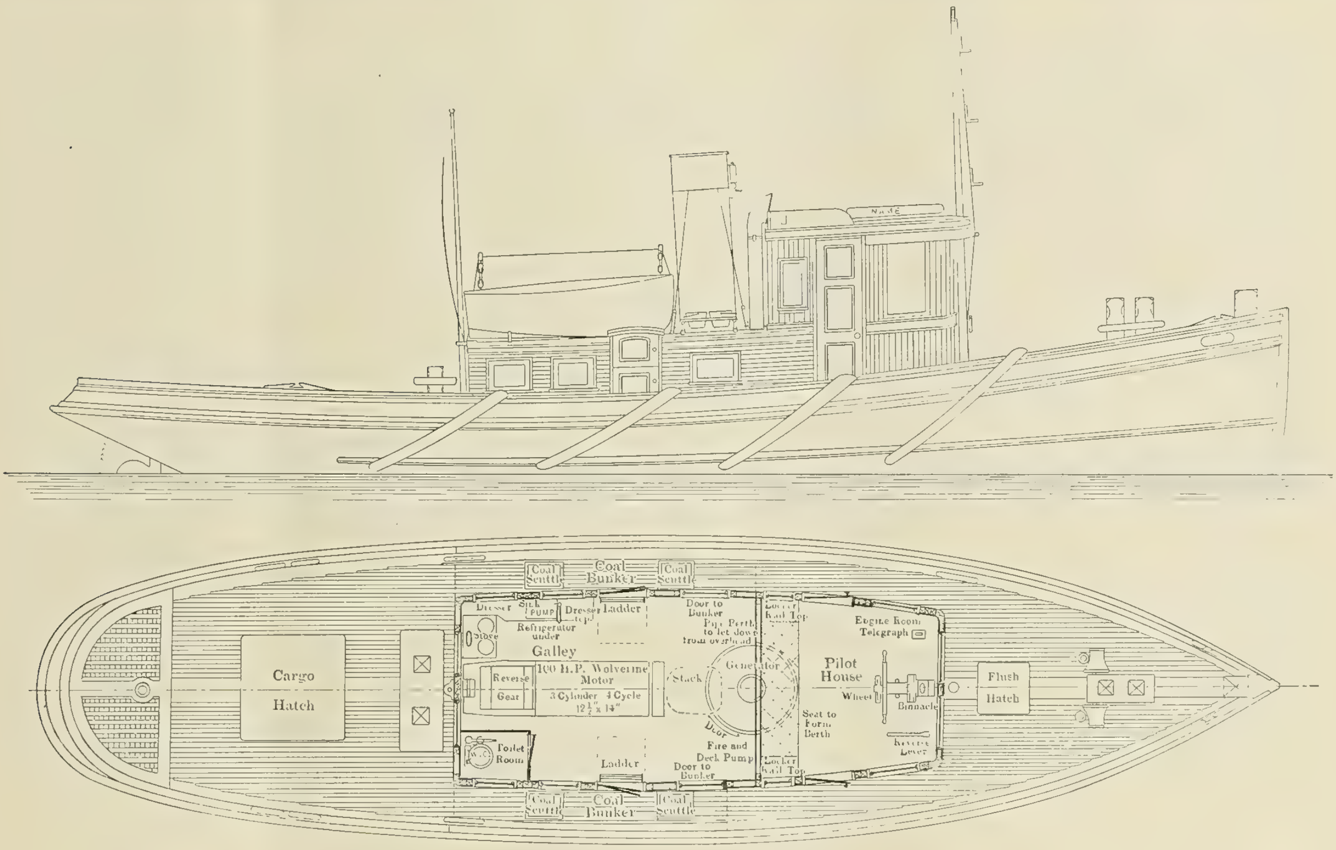
Length over all....................	96 feet.
Length between perpendiculars...	91 feet 6 inches.
Breadth, molded.................	18 feet.
Depth, molded....................	11 feet 2 inches.

The vessels are built entirely of steel, carry one mast and funnel, and are equipped for burning oil.

They are each equipped with one single-end Scotch marine boiler and a vertical triple-expansion engine, with cylinders 11 inches, 18 inches, 29 inches diameter and 18 inches stroke, of 325 indicated horsepower, developing a speed for the ships of 12½ knots.

The most modern whale hunting devices are installed on each boat. A harpoon gun is mounted on the bow for shooting harpoons carrying explosive charges, and each is equipped with air apparatus and towing machines for pumping up the bodies and taking them to the whaling stations.

These vessels represent the most modern ideas in the whaling industry. They are named the *Paterson* and the *Moran* in honor of their designer and builders.



OUTBOUND FROFILE AND DECK PLAN OF A PRODUCER GAS TOW BOAT

Producer Gas Tow Boat

In these days, when we hear so much of producer gas, it is interesting to note the accompanying design for a producer gas towboat from the board of Wm. J. Deed, Jr., naval architect, of Boston, Mass. The design was prepared for a customer, who plans to run a route along the Massachusetts Coast, utilizing the Cape Cod Canal when ready. As there is much towing for tugs that could be done between such points as Boston and Fall River or Providence, this small towboat is being planned to be run economically on short runs, and as she will not have to round Cape Cod after the canal is in use, a smaller, hence less expensive, boat can be used.

The small tug is usually run on about 5 pounds of coal per horsepower-hour. Besides the government requirements of licensed crew the initial expense is considerably more than a gas towboat. With the producer tug no licensed crew is required, and the coal consumption, taking the figures from actual installations now in operation, will be 1¼ pounds per horse-power-hour at the most, including standing-by consumption under banked fires. Added to the economy is the very valuable asset of safety. The producer plant works on the suction principle, below atmospheric pressure, consequently no leakage of gas could occur, and the danger of bursting boiler tubes, gasoline (petrol) explosions or such mishaps is eliminated.

The hull will follow the usual steam tug practice, the arrangement offering a deck and pilot-house to house the machinery and crew of two. The towing bitts are kept well amidships, so as to permit of easy and safe handling of a tow in a seaway. The deck space is large enough to permit carrying passengers on some excursion trip or for freight. In the pilot-house are the wheel and motor controls and a berth, with lockers, for the captain. A pipe berth for the other members of the crew is located in the motor room.

In this motor room is a 100-horsepower producer, made by the Marine Producer Gas Power Company, of New York, and a 100-horsepower Wolverine (three cylinders, 12½ inches by 14 inches) motor. This plant complete will weigh, installed, 17,500 pounds, and will cost $7,500 (£1,540) installed. The fuel bill for a day's run can be easily figured and compared with other powers.

There is capacity for a large coal supply, the coal being stowed about the motor room, under the decks fore and aft, and in regular bunkers abreast the motor room. The cleaner of the producer plant is slung under the roof.

In construction this boat will be extremely strong and heavy. The model being on the hollow keel construction, a rigid deep keel and motor foundation. For such a trip as this boat will make she is eminently suited, as she is inexpensive in first cost, operation and up-keep. She can handle a couple of barges at fair speed and with ease. She is 60 feet over all, 52 feet 6 inches load waterline, 15 feet breadth over guards, 14 feet 4 inches breadth over plank, and 5 feet 3 inches draft.

Two New Naval Vessels under Construction for Cuba

The Cuban Government has manifested its intention to establish a real navy and to take over the burden of policing its own coasts and halting by its own efforts filibustering expeditions. On the 10th of the past October a cruiser and a gunboat for the Island Republic were launched at the shipyard of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, and, happily, upon the anniversary of Cuba's independence.

The gunboat is intended primarily to serve as a training ship for the enlisted men and the cadets of the navy, and to that end the little vessel will be typically up to date and quite equal to the demands of the practical requirements of Cuba's service. The 7-mm. guns are to have field carriages, so that they can be used with landing parties.

Structurally, the *Patria* presents no novelties, but she is representative of the best modern practice. The boat will be driven by twin screws, actuated by two inverted, vertical, triple-expansion engines. The stroke will be of 2 feet, and the cylinders will be of 13-inch, 22-inch and 36-inch diameters, respectively. At full speed, *i. e.*, 16 statute miles an hour, the engines will make 200 revolutions a minute. Steam will be furnished by two watertube boilers of the Mosher type. These boilers will have about 100 square feet of grate surface and something like 6,000 square feet of heating surface. They will

GUNBOAT PATRIA (Copyright, 1911, by R. G. Skerrett)

bluejackets and her embryo officers. The gunboat, which is named *Patria*, has the following principal dimensions:

Length between perpendiculars	185 feet.
Beam, molded	34 feet.
Depth	22.5 feet.
Normal mean draft	12 feet.
Displacement, at 12-foot draft, salt water	1,200 tons.
Speed on measured mile per hour	16 miles.

The armament of the *Patria* will consist of the following guns:

Two 6-pounder rapid-fire guns.
Four 3-pounder rapid-fire guns.
Four 1-pounder rapid-fire guns.
Two 7-mm. machine guns.

All of these weapons are of the United States navy standard, and are mounted as follows: One 6-pounder forward and one 6-pounder aft on the main deck centerline, each gun having, respectively, a train of fire 45 degrees abaft and forward of the beam on either side; two 3-pounder guns mounted on each broadside, one at each corner of the superstructure, and commanding wide arcs of fire, and the 1-pounders, two on each side, placed amidships where they will be able to do effective be placed in one compartment. The boat will also be fitted with a small donkey boiler. The *Patria* will be furnished with the following auxiliary machinery:

One main and one auxiliary feed pump, each of the same size, and either capable of supplying the boilers at full power.
One auxiliary condenser, with combined air and circulating pumps.
Two fire and bilge pumps of duplicate dimensions.
Two water service and salt water sanitary pumps.
One fresh water sanitary pump.
One main air pump.
One circulating pump.
One evaporator and distiller capable of supplying make-up feed and drinking water. These are of the Reilly type.
Two forced-draft blowers.
One steam ash hoist of the direct-acting steam cylinder type.
One ash ejector.

The *Patria* will be provided with accommodations in the deck-house amidships for twenty midshipmen and ten cadet engineers. Each stateroom will be arranged to hold from three to four of these young officers.

The cruiser *Cuba* will naturally be of more military value

than the *Patria*. Apart from her regular naval service the *Cuba* is designed to be the yacht of the president of the Island Republic. The presidential suite is finished in mahogany, and all of the furniture will be of the same rich wood and Chippendale in pattern.

The *Cuba* has the following principal dimensions and general characteristics:

Length between perpendiculars	260 feet.
Beam, molded	39 feet.
Depth	26 feet.
Normal mean draft	13 feet.
Displacement, in salt water, at 13-foot draft	2,055 tons.
Speed on measured mile at 13-foot draft	18 miles.

a watertight protective deck, which is carried down at the sides below the waterline, so as to guard the craft against the admission of large quantities of water in case of injury in the neighborhood of the wind-and-water region. The cruiser is fitted with a double-bottom tank for reserve feed water, and other feed-water tanks will be located in some of the coal bunkers—the compartments being cemented and supplied with all necessary manholes, suction pipes, etc., for the purpose.

Both the *Cuba* and the *Patria* will be lighted electrically and furnished with searchlights. There will be two dynamos and engines of the merchant marine type provided for this purpose. The vessels will be fitted with steering engines of the Williamson Bros. pattern in conjunction with the William

(Copyright, 1911, by R. G. Skerrett) CRUISER CUBA

The *Cuba* will be armed with the following rapid-fire guns, all of United States navy standard:

Two 4-inch, of 50 caliber.
Four 6-pounders.
Four 3-pounders.
Four 1-pounders.
Two 7-mm. Colt guns for landing parties.

There will be one 4-inch gun forward and one aft on the main deck centerline, capable of training abaft and forward of the beam, respectively, on either side for 45 degrees. The 6-pounders will be mounted two on each side at the forward and after breaks of the superstructure. The two forward guns will be able to fire directly ahead as well as 60 degrees abaft the beam, while the after pair will be able to fire directly astern and to train 60 degrees forward of the beam. The 3-pounders will be mounted on the main deck amidships, and the 1-pounders will be placed between these weapons.

The 4-inch guns are protected by armored shields, and the armament of the *Cuba* is calculated to make her a very effective craft against filibusters and smugglers; in fact, a thoroughly excellent boat for the police service, for which she is primarily designed.

The *Cuba* is of steel like the *Patria*. She is provided with

Cramp & Sons arrangement for working the cross-head on the rudder stock by screw gear.

The *Cuba* is a twin-screw craft, and is to be driven by two inverted, vertical, triple-expansion engines, having cylinders of 16, 26.5 and 44 inches diameter and a stroke of 26 inches. At full speed the engines will make 160 revolutions a minute. These engines are fitted with double-bar Stevenson link reversing gears. All cylinders are fitted with piston valves. One main condenser for the two engines is to be placed in the after-part of the engine room; suitable exhaust pipes connecting to both low-pressure valve chests. Two watertube boilers, Mosher pattern, will furnish the steam. These boilers will be located in a single compartment, and will have 135 square feet of grate surface and 6,000 square feet of heating surface. There will also be a small auxiliary boiler. The boilers will be operated under the closed stokehold system, with an air pressure not exceeding 2½ inches of water when steaming at full speed. The auxiliary machinery will be a duplicate of that required for the gunboat.

Both the cruiser and the gunboat will have a wireless telegraph system, and will also be fitted with regulation Ardois light signals.

The *Cuba* will be able to stow the following supply of ammunition:

Four-inch, 200 rounds.
Six-pounder, 600 rounds.
Three-pounder, 800 rounds.
One-pounder, 800 rounds.
Seven-mm. Colts, 2,000 rounds.

The ammunition hoists, of which there will be six, are of Cramp standard type, operated either by electric motors or hand power, and similar in design to those furnished by the makers to vessels of the United States navy.

The *Cuba*, apart from the accommodations for her regular officers, will have quarters for ten midshipmen and cadet engineers.

These vessels are building agreeably to the requirements and inspection of the American Bureau of Shipping, and their combined cost, fully equipped, will represent a contract outlay of $850,000 (£175,000). The vessels will have their trial trips in the spring.

Special attention has been given to thoroughly ventilate these vessels, both by natural and induced draft, so that they may be as comfortable as possible under the climatic conditions of the Cuban waters.

Apart from these vesels the Cuban navy consists to-day of something like a dozen small craft scarcely worthy of mention except three of them, of which one is 339 tons, one of 500 tons and one of 538 tons. The other boats are generally below 50 tons with the exception of two, which boast displacements of 132 and 141 tons, respectively. These vessels have principally been engaged in coastal police and revenue service. In watching for smugglers they have had their time pretty well occupied, because the shallow, hidden waterways along parts of the Cuban shores offer very inviting cover for work of this description.

It is said that the Cuban Government is thoroughly intent upon the upbuilding of a sufficient naval force to patrol its coasts efficiently, and the two vessels building in Philadelphia are only the initial part of the programme.

Lighters and Lighterage in Harbor Freight Transference

BY H. McL. HARDING *

In studying the engineering problem of freight transference along the water front of cities, it is essential to become familiar with the various links which bind together the separated rail and water terminals. Not the least of these links are lighters, with their methods of operating, called lighterage. By lighters, and to a much less degree by drays, water-traffic lines are connected with each other and with rail traffic, and in this way is obtained a practical co-ordination of harbor terminal facilities. There is much to be learned about lighterage, at first apparently simple, but later found to be complex. In New York harbor there is a far greater tonnage of water-borne freight in the slips and piers waiting to be discharged from lighters than the land-conveyed freight from the long rows of loaded drays upon the marginal way. The active congestion is mostly in the slips about the steamships, and the passively waiting congestion upon the other side of the piers. After understanding all the movements of the freight, then being free from prejudice or preconceived ideas, it may be possible to suggest a few principles for easily adapted improvements. That branch of harbor terminal engineering pertaining to freight transference requires personal observation and experience, as little has as yet been published.

The lighter is the water dray. The lighter when covered is called a barge. The usual harbor lighter can transport from 500 to 800 tons of miscellaneous freight; the land dray from 2 to 4 tons. One lighter load may equal 200 or more dray loads.

At New York with railway freight the lighterage charge within the lighterage limits is usually absorbed in the through traffic rate. Within these lighterage limits of the port of New York, when there is a separate charge for lighterage, it is fixed by law at 3 cents per hundred pounds, or 60 cents per ton. Equivalent carriage by drays would average many times as much. Including loading, delays, congestion and unloading, the time consumed by drayage would average at least six times as long.

There is no question but that lighterage is more economical than drayage, and especially so when a fair load can be obtained for the lighter. The towage charge for moving a lighter a few hundred feet is from $2 to $3 (8/4-12/6), for distances requiring one-half hour $5 (1/0/10), and per day $100 (20/16/8). A lighter to be rented for monthly periods with the services of one man is $5 (1/0/10) per day. A number of years ago it was estimated the annual cost of drayage in New York was over $50,000,000 (£10,300,000) annually. Figures of total lighterage costs are not available.

Lighterage is a more important factor in terminal transportation in New York harbor than at any other Atlantic port. Its volume is enormous. This is due to the fact that there are but few connections between the railroads and piers. This condition has produced the great fleets of harbor transportation boats, composed of more than 10,000 craft, of which 1,100 are tugs and steam lighters. These represent an investment of at least $250,000,000 (£51,300,000), and give employment to more than 60,000 men. A large number of these vessels are operated by the transportation companies, but there are thirty independent lighterage and towing companies. As each of these lighters has a capacity from 200 to 800 tons, it will be seen how great would be the total if all could have full cargoes, probably over 5,000,000 tons. Some of the car floats, which are a modified form of lighters, are capable of carrying twenty-three full-size freight cars.

In 1908 the Lehigh Valley had 250 craft, the Baltimore & Ohio 142, and the New York Central 254. In 1907 the New York Central fleet moved 304,372 cars on floats, or about 1,000 cars per day, and in addition lightered 1,402,358 tons of bulk freight, or nearly 5,000 tons per day. Three-fourths of the harbor freight is moved in lighters and similar vessels.

There is no agreed definition of a lighter or barge, and no satisfactory dictionary authority upon which to rely. Definition of a barge in New York harbor would not apply to the barge on the Thames at London. The word bargee, from London, is seldom used along the Atlantic coast. The word lighterman is as well known here as that of stevedore. The following may be accepted as the nearest agreed definition, not, however, without exceptions:

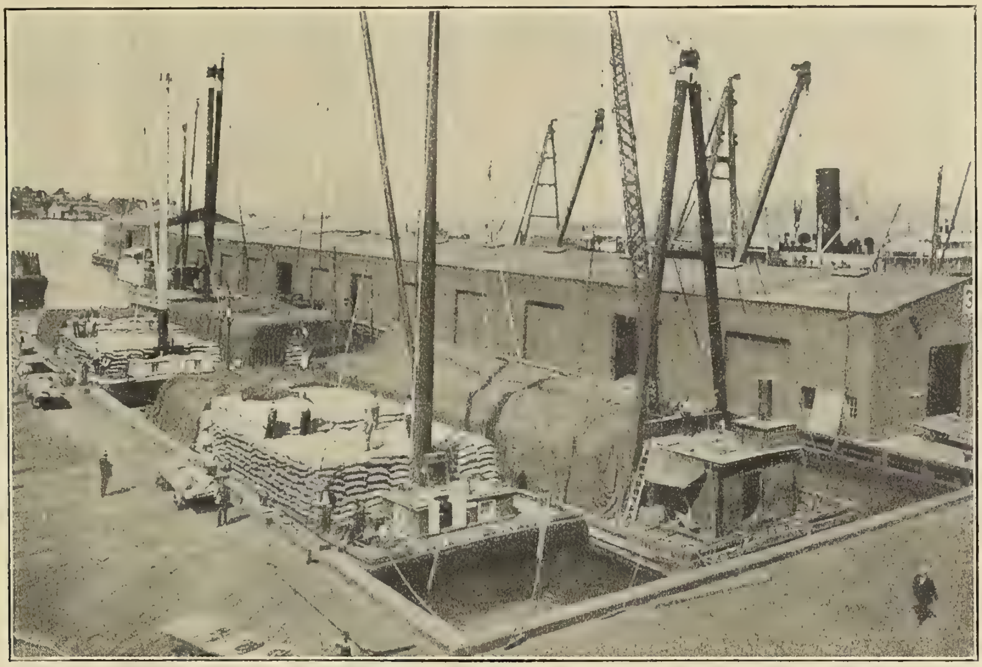
A lighter is a vessel with a deck used for the movement of freight about harbors or in contiguous waters.

The word barge by itself in New York signifies a covered lighter; that is, a lighter wholly or nearly covered with a shed or house to protect the goods from the weather. There are other types of vessels called barges, but these are generally combined with some descriptive word, as coal-barge, ore-barge, oil-barge and schooner-barge, and the word is used with great freedom.

Lighters are of different shapes and construction, some with both ends square, others with a bow like a sailing vessel

* Terminal engineer, 20 Broad street, New York City.

and a rounding or square stern. Some are of wood and others of steel construction. Those with square ends are considered the better, as more easily towed and having greater carrying capacity. A few still have sails, and a limited number are equipped with their own propelling power, but most are designed to be towed. The size of the covered lighter, which is preferred, is 85 to 100 feet long and 30 feet wide. Out of a fleet of forty lighters and barges two were equipped with their own power, in appearance like a large tug with a derrick and space in front for freight, which may be called express freight. Some lighterage firms make no distinction between lighters and barges. This may be due to dock and wharfage charges; North River barges paying 50 cents (2/1) per day dockage charges to the city, while lighters are assessed $1 (4/2). This is manifestly unjust.



FOUR LOADED LIGHTERS. LIGHTER ON RIGHT EQUIPPED WITH A STEAM A DERRICK

At the port of New York the lighterage business is largely controlled by the transportation companies, but there seems to be as much fairness as is generally compatible under similar business conditions. At Philadelphia there is said to be fierce competition between the railroads and the lighterage companies. It is asserted that the freight which comes to a railroad pier must pass over the lines of the railroad controlling the pier. Generally the railroads will not allow lighters to come to their piers and take goods to other rail or water lines.

BROOKLYN PIERS, SHOWING A CONGESTED SLIP. LIGHTERS AND BARGES, TRANSSHIPMENT SHED AND RAILWAY TRACKS ALL CO-ORDINATED

At New York lighters are allowed to load at any piers. In Baltimore harbor many lighters are in service, and the different steamship lines have lighters and barges which collect freight from the various railroad and industrial piers, which freight is thus lightered to the steamship or its pier.

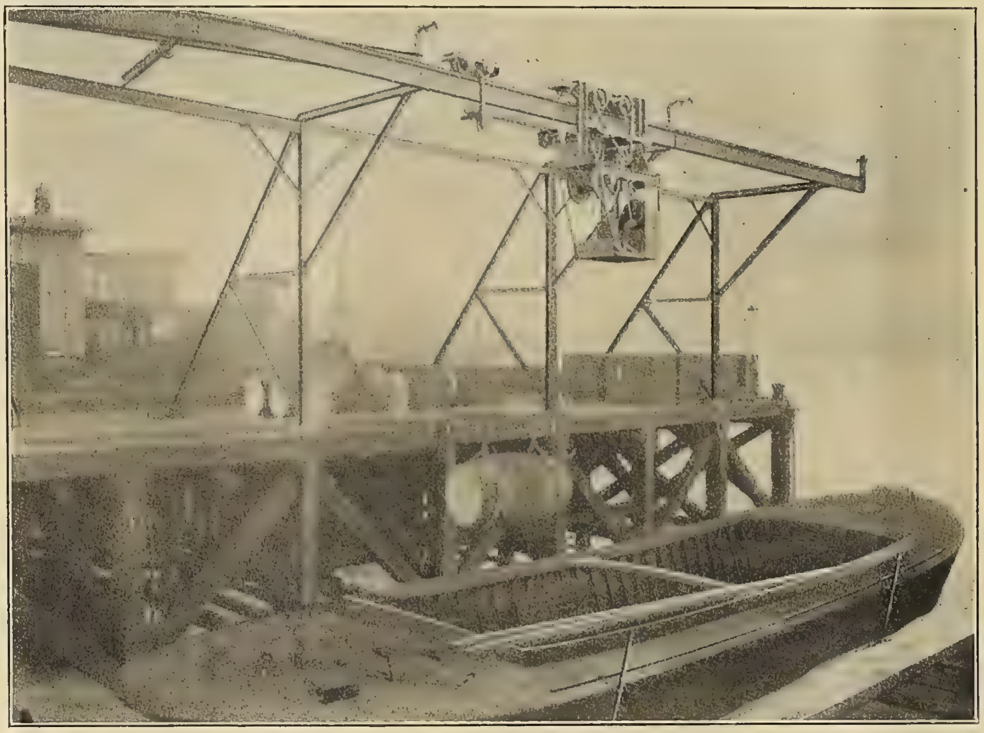
For the purpose of studying the application of machinery to freight transference it is necessary to distinguish between lighters and barges. A covered lighter will, therefore, be called a barge. The object of this paper is to ascertain whether, by means of mechanical methods, the lighters cannot be loaded and discharged more rapidly, thereby removing much of the slip congestion, and in addition reducing the expense of terminal handling between the lighters and the piers, especially when it is necessary to move the freight the whole 100 feet of distance from the landing berth of the lighter, which service may be required of the lightermen. It will make the constructive methods clearer if there is a description of the movement of the lighters and barges about the harbor.

Each transportation company in order to secure as much freight as possible makes many concessions as to the use of its lighters and lightermen. Some arrangements are public and under mutual agreements, such as free transportation within the lighterage limits, which extends from the Battery to 135th street on the North River, the Battery to Jerome Avenue Bridge on the East River, and in New York Bay along the North and East side of Staten Island. There are, however, other concessions, such as at a less than cost price for loading or discharging. The large transportation companies have their own lighters and tugs and deliver through freight free to any terminal in the harbor within the lighterage limits and likewise call for freight under certain conditions. If freight should come by a certain railroad to be delivered to a steamship company, then the railway company would load it upon one of its own lighters and transport it to the steamship or pier and there unload it. If it is to be placed upon the pier the lighterman is not obliged to move it away from his lighter more than 100 feet, and is not required to tier. Where there is not sufficient adjacent room upon the pier, then the recipient of the freight often furnishes men, without charge, to help the lighterage men to move the freight a longer distance, or to assist in tiering. The man in charge of the lighter bringing the freight generally hires his own men from the dockmen, or men are provided by the recipient transportation company and charged to the lighterage company bringing the freight.

The price for moving the freight from the pier to lighter or from lighter to pier varies per ton, according to character of the freight, being less for heavy freight, such as copper, more for miscellaneous freight, varying from 10 to 20 cents (0/5-0/10) per ton. This is supposed to be the cost of the manual labor and is charged against and in the freight rate. It means, however, only the movement between the lighter and the pier. The price charged against this freight movement may not cover the cost, but is made up in the freight charges, the securing the business being of sufficient inducement to permit here a small loss.

In many cases the freight is transferred from the steamship across the pier directly upon the lighter without rehandling the loads. In this case the loads are not transported a greater distance than if they were taken either up or down the pier and placed there instead of upon the lighter. In such a case the cost to the steamship company is no more than if the freight be placed upon its pier, and often there is but a nominal, if any, charge to the lighterage company. There being no rehandling or lifting it is possible to place the freight upon the lighter without expense to the steamship company. The great expense in terminal freight movements is not in the mere horizontal movement but in the lifting and preparing for the horizontal movement.

Lighters are often placed on the other side of the pier opposite the ship, often two or three side by side, and also alongside the pier upon the same side as the steamship if the pier be of sufficient length. Lighters are also placed upon the off-shore side of the ship along the whole length of the vessel, and often in two rows. Wherever room can be found a lighter is there squeezed in. There is naturally much congestion and

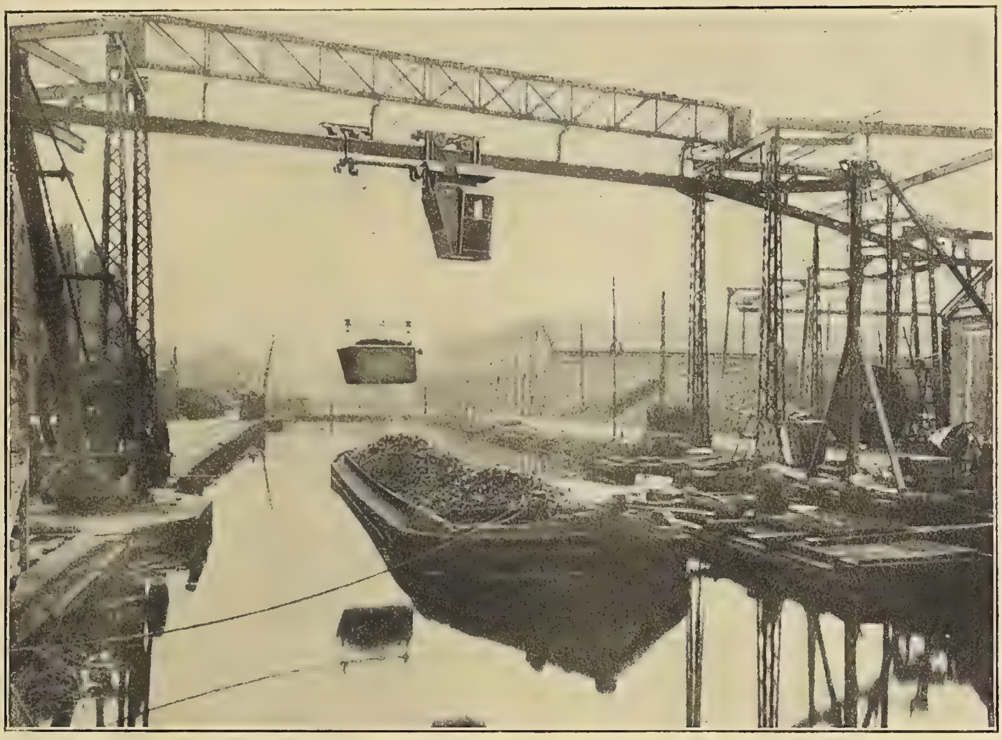


AN ECONOMICAL INSTALLATION FOR SMALL INLAND RIVER WHARVES. HIGH AND LOW WATER NO OBSTACLE

delay, but everything is done to prevent delay. As soon as a lighter is loaded or unloaded it is generally removed by the tugs of the steamship company to some convenient place, as at the end of the pier, awaiting a tug of its own transportation company, or if part of the steamship's inbound cargo it is carried to its destination within the harbor limits. A large proportion of inbound freight, if of general merchandise or for different consignees, is transferred over the piers in order that it may be inspected, assorted and distributed to the different lighters, according as each lighter is for a different destination.

An example of this is seen in cotton, each bale of which must be carefully examined for condition and for marks and cross-marks. In fact, most all of the package freight must thus be passed over the pier. A full lighter load, or in some cases powerful hoisting machinery, some 100 tons capacity, for transferring boilers, engines or similar heavy units, from other lighters into the ship's hold. Often pieces of machinery, on account of bulk or weight, must be loaded in the ship directly under the hatches, so as to avoid the expense of moving between decks. They must therefore be held until the vessel is otherwise loaded. In order to avoid demurrage these heavy units are transferred from the foreign lighter to the deck of the lighter equipped with the powerful derrick and there retained until the ship is ready to receive them, thereby saving demurrage.

Where there is a certain amount of lighterage freight which is accustomed to be delivered to a transportation company daily or at specified times, then there is generally a space reserved for such lighters alongside the pier or vessel.



AN ENGLISH COAL BARGE. APPARATUS FOR CONVEYING COAL FROM THE BARGE TO THE REMOTE BUILDING ON THE RIGHT

less, of inbound freight for one location, or for one consignee, may pass over the ship's side directly upon the lighter.

As the freight comes from the vessel upon the pier the checkers decipher the marks and direct the load to pass across the pier or up or down the pier, and the routers point out the particular lighter, and men at the gangways opposite the lighters make another inspection of the marks as a final check against possible errors.

Lighters often do not convey their full loads on account of the expense of tiering. In one case only about 200 tons of bags of rice were placed in the barge instead of its capacity of 500 tons, on account of the labor cost of higher tiering being more than the cost of lighterage. It was cheaper to make two trips than to tier higher by manual labor.

Outbound package or miscellaneous freight almost invariably passes over the pier, so that it can be inspected, counted, checked and, if necessary, measured or weighed. Outbound bulk freight, or structural steel or similar freight, is generally taken from lighters, placed on the off-shore side. When there is not room on the off-shore side freight then passes across the pier.

One lighter and sometimes two in a fleet are equipped with

It often happens that a lighter has to deliver a part of its cargo to another company at a different pier. As far as possible the opportunity for quick unloading is afforded, but often there are vexatious delays. In such cases the lightered freight may be left upon the end of the pier some 600 or more feet from the ship's gangway, thereby greatly adding to the steamship's terminal-handling cost.

Any modern plans for harbor improvement should give careful consideration to affording ample facilities for the transferring of lighterage freight between lighters and the piers and vessels. There should be slip room between the piers equal to four or five times the width of the widest steamship to be there berthed, so that there may be sufficient space for the lighters on the off-shore side. There should be transferring machinery on the piers, and special lighters should be equipped with similar machinery, so as to load and discharge the lighters in the shortest possible time to prevent the congestion of lighters in the slips and to avoid demurrage. One of the chief functions in the organization of a harbor is rapidity of freight movements, which is facilitated by lighterage.

There is the greatest congestion and delay on the off-shore side of steamships, due to many causes, one of which is that

the freight can only be loaded into the steamer as it can be properly stowed. It will not do to stow heavy freight upon or in close proximity to fragile freight, or that which may break or tarnish that of a more delicate nature. The stowing of the freight in a steamship not only requires excellent judgment, but there must be an opportunity to select at the proper time that freight which will be best suited to the vacant spaces. It therefore often happens that a lighter is held alongside the pier away from the ship until the stevedore says he is ready to receive its cargo.

An ideal system of freight transference between steamships and lighters would be by means of a narrow pier upon each side of the ship and the lighters on the other side of these narrow piers. On account of lighters not being the only transporting agencies this is not practical, but it can be approached by equipping with modern freight-handling machinery a long lighter or float, with or without decks, which can be placed alongside the ship and other lighters alongside this float. Such a float, 250 feet long and 35 feet wide, would have a capacity when tiered only 12 feet from the floor of more than 1,500 tons. Some of the car floats in New York harbor are 317 feet in length and are easily handled, and this length could be used instead of 250 feet. By means of a machinery float of this description, properly equipped and protected from the weather, merchandise can be taken directly from lighters to the hatchways of the steamers or to the side ports without any rehandling, or can be unloaded from lighters upon this float and left with slings about them, and then, without any rehandling by manual labor, be lifted by the machinery to the vessel. The same is true of discharging. If the steamship be discharged upon this float and the float be filled, it can be moved and replaced by a similar empty float and lighters loaded from the empty float. By thus utilizing these floats, lighters can be readily loaded or discharged. The chief function of this float is providing machinery for quick, direct freight movements between the lighter and vessel on the off-shore side and also to enable lighters to be loaded from the float. There must, however, be no manual rehandling. Such machinery-equipped lighters may be considered the equivalent of an extra pier. The above might serve as one type of machinery-equipped lighter, though not by any means the only one.

Any machinery to be installed must be able to take freight from the lighters across the piers to the vessel or to any points upon the piers; that is, to be able to serve every foot of floor or vertical space, including all the usual intermediate operations, and also there should be provision for the reverse movements. All this work must be without rehandling by manual labor and with continuous rapidity. As the operations at the beginning and end of freight movements, such as assorting and lifting, distributing and tiering, are more important than the mere conveying any machinery to produce the continuous rapidity necessary must be able to hoist as well as convey.

As, by properly designed machinery installed under expert engineering advice, the freight can be lifted from the deck of the lighter, located alongside the pier or the steamship, and taken into the hatchways of the vessel without manual rehandling, the present average cost of transference can be reduced at least 50 percent, due allowance having been made for maintenance and amortization of the machinery. There can also be attained that which is considered of more importance; that is, much greater rapidity in loading and discharging. The usual precautions, so as to protect the barge freight from the weather during transit and while being loaded or discharged, have received careful consideration. The one dominant provision to which everything else has been subordinated, so as to secure rapidity, economy and the least breakage, has been freedom from rehandling by manual labor.

The British National Experimental Tank

BY PROF. HAROLD A. EVERETT

The idea of a National experimental tank in England and its realization are both due to Mr. A. F. Yarrow. At the Glasgow meeting of the Institution of Naval Architects in 1901 he proposed that an experimental tank should be established under the auspices of the Institution, at which model experiments should be carried out for shipbuilders and others, and a committee was appointed to take steps to realize this. Sir William White, in his paper read before the Institution in 1904, emphasized the opinion expressed by the president, the Earl of Glasgow, in his address to the Institution in 1903, when dealing with the work of this committee, that the establishment of a tank for the purpose of systematic research into general principles was an urgent matter, and that such a tank should be located at the National Physical Laboratory. Mr. Yarrow's generosity made this scheme possible, when in April, 1908, he offered to find the sum of $97,500 (£20,000) for the construction of the tank, provided suitable provisions were made for conducting research work and for experimental investigations of a confidential character. With this object he suggested that a guarantee fund of $9,750 (£2,000) a year for ten years should be raised.

In response to this offer the Institution of Naval Architects raised a fund of $6,525 (£1,340), and the executive committee of the laboratory undertook the responsibility of finding the additional sums required to work the tank. An advisory committee, consisting largely of representatives of the Institution, has been appointed with a view of keeping the work of the tank in touch with the needs of shipbuilders and naval architects, and the tank itself is to be opened just ten years after Mr. Yarrow's first proposal.

The following is a brief description of the tank and of the apparatus installed:

THE LARGE TANK

There are two water basins, the largest constructed of concrete, varying in thickness from 2 feet to 4 feet in places. The dimensions of this basin are:

Length	550 feet.
Breadth	30 feet.
Depth	12 feet 3 inches.

It is provided at the north end with docks for storage and for easy access to the models, at the south end with a shelving beach to eliminate the waves formed by the models.

The models used for experiments in this basin will vary in length from 14 to 20 feet, and will be towed along the waterway from a carriage, electrically driven, which runs on rails secured on either side to the top of the tank walls. This carriage will travel at any speed from 1 foot per second to 25 feet per second.

The equipment of the carriage consists of a grip for holding the model during the acceleration and retardation periods; guiding frames at each end to keep the model on a straight course without restricting its vertical motion; a spring dynamometer by which the model is towed when a steady speed has been reached. The speed of the carriage is obtained by recording time and distance, the former being given by a clock which makes and breaks each half second, and the latter by an electromagnet, the circuit of which is completed by catches fixed on the rails at 20-foot intervals.

THE SMALL TANK

The dimensions are:

Length over all	63 feet.
Breadth	5 feet.
Depth of water	3 feet 3 inches.

A rotary pump is fixed in the tank at the north end, which

will enable model experiments with flowing water to be made. For still-water experiments pits 16 feet deep have been constructed on the middle line at each end of the tank. The model will be propelled and retarded by dropping and raising weights in either pit, the pull of the weights being transmitted to the model by a fine wire. The speed of the model will be measured by a vibrating rod of known frequency.

MODEL MAKING

The models are made of paraffin wax. The wax is heated in a tank surrounded by hot water which is kept circulating by a small boiler. The castings are made in a clay mold. The tank containing the clay is arranged so that two molds for 20-foot models may be prepared at the same time. A traveling cutter is arranged on top of the mold tank for trimming the upper surface of the castings.

The models are shaped to the correct form by cutting a series of horizontal grooves in them on a special machine, and trimming the wax down by hand to a fair and smooth surface, leaving only the finest trace of these grooves. The shaping machine will deal with models of a maximum length of 25 feet. A table for measuring the finished model or marking any desired lines on the model has been installed.

Steam Trawlers Surf and Swell

The steam beam trawlers *Surf* and *Swell* were launched Dec. 9 at the yards of the Fore River Shipbuilding Company, Quincy, Mass. Following are the general dimensions:

Length between perpendiculars.....	120 feet 6 inches.
Length over all....................	129 feet 6 inches.
Breadth, molded	22 feet 6 inches.
Depth to main deck................	13 feet 6 inches.
Mean designed draft...............	10 feet 6 inches.
Indicated horsepower	400

These vessels have straight stem, semi-elliptical stern, raised quarter-deck and turtleback topgallant forecastle, and are rigged as pole-masted ketches. The fish hold has a capacity of 50 tons of iced fish, is insulated throughout with cork and sheathed with spruce, and is divided into bins fitted with portable sides, so that the catch after being sorted in the ponds on deck may be stowed, having the different classes of fish entirely separated.

On the main deck directly over the fish-hold there is an ice-crushing machine, through which about 10 tons of commercial blocks of ice can be fed into the hold, broken up into small pieces of a size best suited for the preservation and stowing of fish. The engine for running this ice crusher is so arranged that it can be used for handling the cargo on arrival at the fish wharf.

There is a turtle deck forward, and upon this deck is located the anchor-handling gear. On the main deck forward there is a steel deck house, containing lamp and paint rooms and entrances to the forecastle and cargo. On the quarter-deck aft, and embodied with the engine casing, is another deck-house of steel, which contains quarters for two firemen and entrance to the cabins and engine room. In the forecastle are pipe berths and lockers for the accommodation of fourteen men, with a galley and mess room located just aft of the forecastle, containing a shipmate range, refrigerator and ice-box and the necessary equipment and outfit for the accommodation of the entire crew and officers. In the after cabin there are four berths, with the usual lockers, seats and table, as required for the accommodation of the ship's officers. The captain's cabin is located on the port side and a cabin with two berths for the engineers on the starboard side.

For handling the trawl nets and otter boards there are the usual gallows frames and an 8-inch by 14-inch double-drum winch, supplied by the Hyde Windlass Company, together with the necessary revolving bollards and fittings to give the required leads for trawl lines.

The vessels are lighted throughout by electricity, the generator set being one of 2½ kilowatts, 110 volts, built by the General Electric Company.

Steam is supplied by one Scotch boiler having a working pressure of 180 pounds, and is of 12 feet 6 inches mean diameter and 10 feet 6 inches long, with two Morison suspen-

LAUNCHING OF THE SURF

sion furnaces 42 inches diameter, having a heating surface of 1,568 square feet and a grate area of 42 square feet. The main engine is of the triple-expansion vertical type, having cylinders of 12¾ inches, 22 inches and 36 inches diameter by 24 inches stroke, developing 450 indicated horsepower at 110 revolutions per minute. The condenser is cast onto the back columns of the main engine, and the air, bilge and feed pumps are driven off the intermediate-pressure crosshead.

Personal

MR. SIDNEY G. KOON, M. M. E., for four years editor of INTERNATIONAL MARINE ENGINEERING, and later metallurgist for the Jones & Laughlin Company, is now associated with Mr. Walter B. Snow, publicity engineer, 170 Summer street, Boston, Mass. Also a short time ago Mr. John S. Nicholl, B. S., lately with the New York Edison Company, and formerly acting manager with F. W. Horne, importer of American machinery, Yokohama, Japan, became associated with Mr. Snow's staff.

Obituary

A. CARY SMITH, 74 years of age, famous as a designer of racing yachts and merchant vessels, died Dec. 8 at Bayonne, N. J. Mr. Smith designed one of the America's Cup defenders and many schooners, sloops and yawls that have crossed the Atlantic and were consistent winners of races for years. Among the steam vessels designed by Mr. Smith were the *Richard Peck*, the *City of Lowell* and the *Chester W. Chapin*, and the yacht *Meteor*, built for the Kaiser.

Latest Dreadnoughts for South American Republics

In beginning the upbuilding of strong naval powers, consistent with the natural resources and rapidly-growing industrial and commercial importance of the largest and strongest South American Republics, it must be expected that the latest types of battleships and destroyers should be adopted, and it is not surprising to find that the initial steps in this direction have resulted in the creation of dreadnoughts larger and more powerful than any that had been constructed by other naval powers at the time of their design. Of most interest is the recent naval construction for Argentina and Brazil.

Argentine Battleships

The recent launching of the *Rivadavia* at the yards of the Fore River Shipbuilding Company, Quincy, Mass., May 26, 1911, and the *Moreno* at the yards of the New York Shipbuilding Company, Camden, N. J., Sept. 23, 1911, give an opportunity to recapitulate the main characteristics of these dreadnoughts and compare them with the recent additions to the Brazilian navy. The Argentine battleships have a normal displacement of 26,500 tons at a draft of 27 feet 6 inches. The full-load displacement is 27,500 tons. The principal dimensions (see INTERNATIONAL MARINE ENGINEERING, May, 1910) are: Length over all, 604 feet; length between perpendiculars, 585 feet; beam, 95 feet 6 inches; depth, 49 feet 7 inches. The total weight of armor is 7,600 tons, 680 tons of which consist of nickel steel, disposed so as to protect the hull from mine and torpedo attack. The main armor includes a 12-inch belt at the waterline 200 feet long, which is reduced to 10 inches for 75 feet further at each end and finally tapers to 5 inches at the ends. Above this throughout the length of the vessel is a belt 9 inches thick tapered to 8 inches at the upper deck. Six-inch armor forward and 4-inch aft is used in the upper part of the structure.

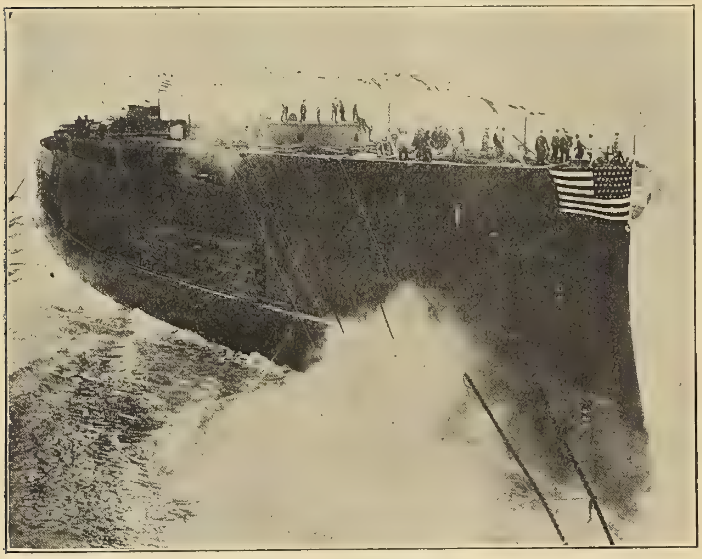
The armament consists of twelve 12-inch 50-caliber guns mounted in pairs in six turrets, arranged to fire on either broadside, and six of them forward and six aft. There are also twelve 6-inch 50-caliber guns in the main citadel and twelve 4-inch 50-caliber guns.

The vessel is propelled by triple screws driven by Curtis turbines, with a total horsepower of 39,500. The turbines are located in three separate compartments, and steam is provided by eighteen Babcock & Wilcox boilers, fitted to burn both coal and oil, and located in six watertight compartments, three of which are forward and three aft of the engine rooms. The bunker capacity includes 4,000 tons of coal and 660 tons of oil, giving a radius of 10,500 miles at 11 knots, 7,200 miles at 15 knots and 3,600 miles at 22.5 knots. The designed speed of the ship is 22.5 knots.

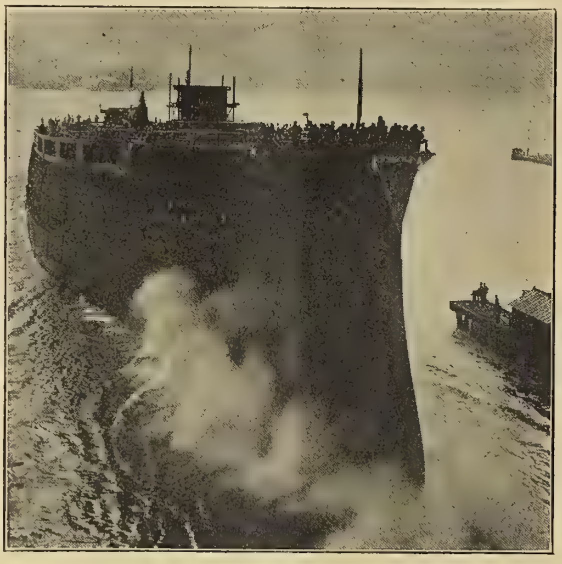
Launching Details

Nice engineering judgment is involved in bringing a big ship to a standstill after she leaves her launching ways. Theoretically, the problem seems a very simple one, but the case of the *Rivadavia* at the Fore River yards furnishes a very pretty example of the way in which calculation has to be tempered by good judgment in order to secure a successful launching. The *Rivadavia's* launching weight was just under 11,000 tons. In calculating the resistance required to check the *Rivadavia* after she was afloat it appeared that the accumulated energy of the ship, just as she left the ways, would amount to about 7,000,000 pounds. This amount of resistance was to be applied in the shape of manila rope stops connecting fixed chains to chains attached to dogs on the vessel's bow. On each side of the ship there were four sets of heavy chains, two fixed, these being anchored to "dead men" sunk deep in the ground; the other two being attached to dogs on the ship. The ship's bow before launching was about even with the anchors of the land chains; the ship chains on each side were first laid aft well onto the quarters, and were then brought forward again towards the bow until their shore ends nearly reached the anchors of the fixed chains. On each side of the ship, therefore, a land chain and a ship chain lay parallel on the ground for a distance of about 400 feet. The chains thus paired were connected by fifty-two stops, or rope cable joinings, in each pair; the stops were about 20 feet long, and the last two of each group of fifty-two—that is to say, the two which would break last—were double. The resistance offered by the cable stops, therefore, was the breaking strength of 200 single strands of manila cable, plus the breaking strength of eight sets of double strands.

Here judgment enters. The blocking under the stern of the



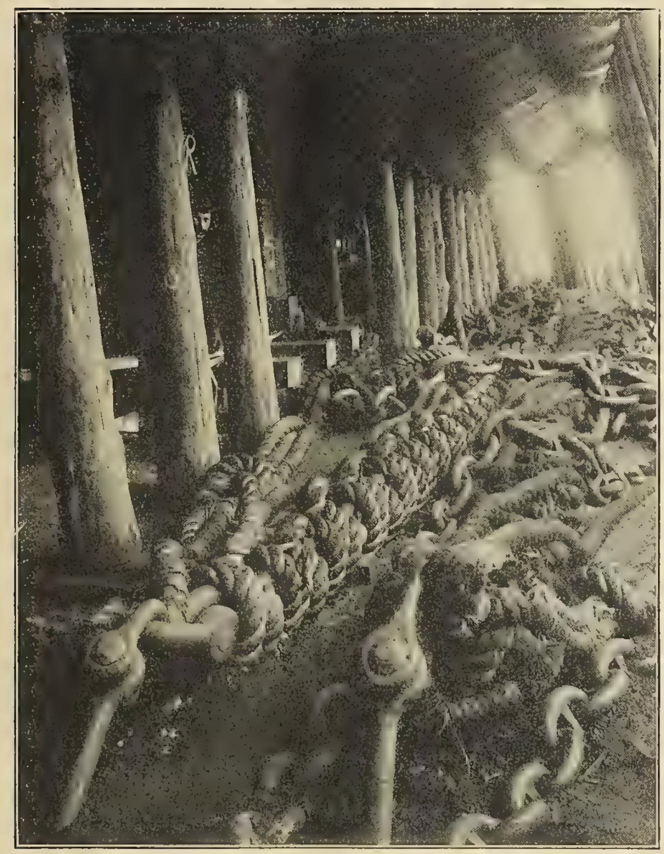
LAUNCH OF THE RIVADAVIA



LAUNCH OF THE MORENO

ship, between the stern and the sliding ways, would offer considerable resistance as the ship slid stern first into the water; but it was obviously impossible to calculate with any accuracy the amount of this resistance. Another variable was the condition of the grease with which the ways were flushed. All previous battleship launchings at the Fore River yards had been in November, so the August heat had to be considered. A certain softening of the grease, provided that this softening did not result in making it too thin, would give the ship more than the calculated speed based simply on her weight and the inclination of the ways. The calculation showed that 8-inch manila cable would offer ample resistance, but Manager Smith, of the Fore River Company, decided to use 9-inch cable, and the result justified his judgment.

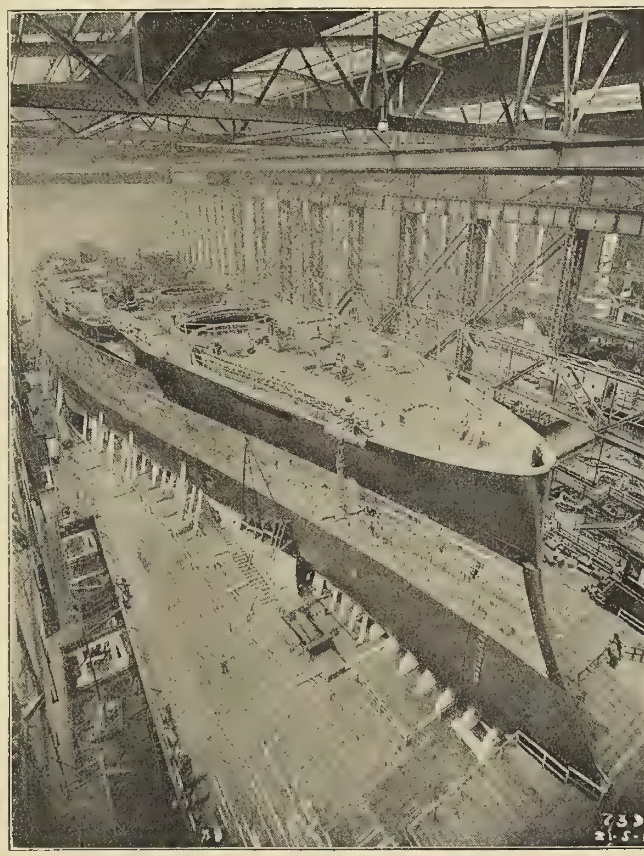
The stops were therefore made of 9-inch manila cable, manufactured by the Plymouth Cordage Company, and having an estimated breaking strength of 65,000 pounds. A 20-foot stop of this cable stretched about 6 feet before breaking, and the successive stops between the chains were so arranged that the second stop came under strain and began to stretch before the first one was broken, while the third stop came under strain before the second stop was broken, and so on down the line. This arrangement provided a nearly constant resistance to the momentum of the ship, the heaviest resistance being provided in the four double stops at each side, which would come into play only when the ship had presumably lost most of her headway. As a matter of fact, every stop, both single and double, on each side of the ship broke, and the ship came to a standstill in the water less than 10 feet from where the last stop gave way. The expenditure of first quality manila cable was necessarily very large; 24,000 pounds of the finest Plymouth manila rope were used for the stops, and this 12 tons of cable was destroyed in less than ten seconds, that being the period of time during which the resistance of the rope was used to bring the vessel to a stop.



MANILA STOPS USED AT THE LAUNCHING OF THE RIVADAVIA

THE BRAZILIAN BATTLESHIPS

The Brazilian navy may be divided into two distinct parts—the present fleet and the vessels ordered in Great Britain under the administration of President Affonso Penna, according to the 1906 naval programme. The present fleet may be said to be composed of thirty-one units, including eight small vessels for the patrol of the inland river stations and three transports. These ships are all somewhat old, with the possible exception of the two coastguard cruisers *Deodoro* and *Floriano*, of 3,162 tons each, and the four torpedo destroyers, *Tupy*, *Tymbira*, *Tamoyo* and *G. Sampaio*, of 1,190 tons. The cruiser *Barroso*, of 3,450 tons, is to be turned into a modern training ship. The new Brazilian fleet is composed of three battleships of no less than 19,280 tons each, the *Minas Geraes*, the *Sao Paulo* and the *Rio de Janeiro;* two scouts, the *Bahia* and the *Rio Grande do Sul;* ten torpedo boat destroyers of about 560 tons displacement; three submarines and two auxiliary vessels. The *Minas Geraes*, built by Sir W. G. Armstrong Whitworth & Company, Ltd., and the *Sao Paulo*, built by Messrs. Vickers, Sons & Maxim, Ltd., were delivered at Rio Janeiro in the fall of last year.



VIEW SHOWING DECK ARRANGEMENT OF THE MORENO

The *Minas Geraes* and *Sao Paulo* are sister ships, and the following is a table giving their main features:

Length over all	543 feet.
Length between perpendiculars	500 feet.
Breadth, molded	83 feet.
Depth, molded	42 feet 3 inches.
Draft	25 feet.
Displacement at 25 feet draft	19,280 tons.
Speed at full power	21.623 knots.
Indicated horsepower	28,645
Normal coal capacity on 25-foot draft	800 tons.
Total bunker capacity	2,360 tons.
Radius of action determined on 48 hours' trial at 10.6 knots	12,813 sea miles.

ARMAMENT

Twelve 12-inch 45-caliber guns.
Twenty-two 4.7-inch 50-caliber guns.
Eight 3-pounder guns.

ARMOR

Broadside, 9-inch, 6-inch and 4-inch cemented steel.	
Protective deck	2 inches.
Main bulkheads	9 inches.
Gun barbettes	12 inches.
Forward and after athwartship bulkheads	3 inches, 4 inches.

MACHINERY

Engines, triple-expansion, four-cylinder type.	
Diameters of cylinders, high-pressure, 39 inches; intermediate, 63 inches, and two low-pressure, 73 inches; stroke, 3 feet 6 inches.	
Total cooling surface of condensers	24,000 square feet.
Boilers, 18, Babcock & Wilcox type.	
Heating surface	58,370 square feet.
Grate area	1,686 square feet.

The difficulty of accommodating such extensive gun equipment, while affording the maximum arc of training for each gun, falls upon the naval architect. The weight involved for a pair of 12-inch guns—approximately 500 tons, exclusive of the 9-inch armored walls of the barbette, which add 100 tons—makes it imperative that in action the guns should be of the greatest service. This is the more essential when one also reflects upon the cost of training and maintaining the gun crews. The engine designer, on the other hand, makes great demands upon the deck space for his boiler up-takes and engine-room ventilating shaft. The ultimate test of efficiency rests upon the compromise made between the two claims. The two boiler up-takes occupy the minimum of deck area, and the after one is ingeniously arranged in order to overlap, to a certain extent, the two engine-room shafts. Around the up-takes is built a superstructure, on the lower platform of which there is arranged, forward, adequate latrine accommodation for the men whose quarters are in the main and middle decks below, and aft the cuisine department, with its extensive stores. The upper platform serves as an officers' promenade, and around it are hammock-stowing cases, which afford protection against small gunfire. The boats are housed on the top of this superstructure, with the exception of the two "sea" boats, which must always be slung for immediate lowering. These boats are carried on one heavy double-derrick structure on each side, built up of channels and braced with transverse channel irons and diagonal bars. These derricks are pivoted at their base, and by means of the boat hoists can be canted outwards to enable the boats to be lowered. The ordinary boats are shipped and unshipped by hydraulic hoists on the superstructure deck and derricks fitted to the vertical member of the tripod mast. On this mast there is carried the gun-control station, with yards for signaling and the aerial telegraph wires. The superstructure essential to boilers and machinery, to give a maximum of about 25,000 horsepower, thus occupies less than one-third of the length of the ship, and a like proportion of the width.

Forward, as well as aft, it has therefore been possible to fit two gun-houses in the center line of the ship, these each accommodating two guns of 12 inches bore and 45 calibers in length. Amidships, on each side, there is a similar gun-house; and in order to allow the immense armor hood protecting the ordnance machinery to rotate through 180 degrees the deck structure is cut away in a semi-circle. Otherwise the upper deck of the ship is free of obstruction. This freedom from obstruction is one of the notable features of the ship. Four of the gun-houses are on the upper deck level, but the after of the pair of turrets forward and the forward of the pair of turrets aft are on a level some 12 feet above these, so that the guns in this case may fire over the guns in front of them. The centers of the turrets of each pair are about 36 feet apart. Thus eight guns may fire forward, including the four amidships, eight aft and ten on either broadside. In this way, it will be recognized, an unusually high proportion of gun power is utilizable under any conditions of warfare, while the higher elevation of four of the guns gives them a very considerable advantage.

The central superstructure in the ship has been utilized for housing at the forward end, on two different levels, four 4.7-inch guns, two on each side of the bridge, firing forward in line with the keel, with a considerable angle of fire abaft the beam, while aft there are also four such guns similarly arranged. Six 3-pounder guns have been housed in the superstructure, and two others are placed one on the top of each of the higher 12-inch gun-houses, forward and aft. In addition, there are on the main deck, and therefore within the citadel of 9-inch armor, seven 4.7-inch guns on each side of the ship. The upper works forward and aft are indented, in order that the forward and aft 4.7-inch guns on each side may fire ahead or astern in line with the keel as well as the beam. There are in all twenty-two 4.7-inch guns. The broadside fire, therefore, aggregates ten guns firing 850-pound projectiles, eleven guns firing 45-pound projectiles, and six guns using three-pounder projectiles. As in each case great rapidity of fire has been ensured, the armament constituted the most formidable attack yet provided for in any battleship afloat at that time.

To conform to the desire of the Brazilian authorities, electricity is utilized for the training of the turrets. Otherwise, hydraulic power is applied, and for every operation there is emergency gear, either of the hydraulic type or for manual working. Air blast is fitted for clearing the gun immediately after each round has been fired, and there is a water spray on the rammer, which plays upon the obturator pad immediately the breech is open, to ensure that any sparks then remaining may at once be extinguished. The guns are arranged to be operated through eighteen degrees of elevation, and the gear is so designed that the guns must be loaded at five degrees of elevation. The hydraulic power for elevating each gun is normally under the control of the captain of the turret, but for loading operations the main valve is thrown out of gear, so that the gun at once returns to the five degrees of elevation, and, having been loaded, is again placed under the control of the captain of the turret for elevation to suit the objective. The recoil is taken up by hydraulic cylinders in the usual way.

The loading machinery is on the two-stage system, so that there is no possibility of the magazine being jeopardized by any accident at the gun platform. The shell rooms under each turret are sub-divided, and in this connection it may be stated that a shell chamber has been arranged between the two engine rooms. The shells are traversed from their bins by an overhead hydraulic traverser, using toggle-jaw clips, and arrangements have been made so that this traverser can be worked by hand. A circular traversing rail is arranged round the hoist trunk, and the tray for loading the projectile into the hoist cage travels with the trunk when the turret is being trained. The door admitting the shot into the cage is interlocked with the cage itself. The charges of ammunition are loaded by hand on the level above the shell rooms. The charge is put into a hopper in the central portion of the trunk, and falls into the upper tray of the hoist cage. The cage is elevated by an hydraulic ram working through rope gear to the working chamber level, where the charge and projectile are driven by an hydraulic rammer into the upper or gun-loading

hoist cage, which travels to the gun-loading position on guide rails set to the required curvature. The breech of the gun having been opened, the upper travel of the cage tilts a loading tray into the breech of the gun, in order to protect the screw-thread of the breech. The rammer in use is of the usual chain type, and its first motion locks the cage, which must, consequently, remain in position until the gun has been loaded. When the chain rammer is withdrawn from the breech the cage falls, and the tilting tray is then automatically withdrawn. The tilting tray has a locking bolt fixed to a slide arm, which locks the valve of the breech opening and closing motor, so that the breech block cannot be operated during the process of loading. It will thus be seen that from first to last every action must follow the proper sequence from the moment the charge is put into the hoist at the base of the turret until the gun is loaded and the breech closed again.

The lower and upper cages can be worked by two distinct hydraulic systems, electricity being used to supply the emergency hydraulic power. The turret is trained by a variable speed motor, a separate installation of motor generators being provided in each turret to supply the current, and there are suitable resistances to compensate for the variable speeds required. The worm-wheel is fitted with friction plates, which are kept up to their work by Belleville springs, so that there can be no shock upon the motor should the training gear come hard back against the stops on the turn-table roller path. On the worm-shaft two bevel wheels are fitted for transmitting, through chain gear, the manual power for training the turrets. The electric current for training the turrets is supplied from the main electric installation on board the ship, which include six generating sets, consisting of engines and dynamos, the collective electric power being 3,600 amperes at 220 volts and 400 revolutions. There are three hydraulic pumps, in separate engine rooms—two forward and one aft—connected with one system of pipes, the pressure being 1,000 pounds to the square inch. One of these pumps is practically sufficient to operate the six turrets.

Great care has been exercised in connection with the cooling of the magazines, and four of Hall's CO_2 machines are provided with a collective capacity of 300,000 cubic feet of air per hour—a capacity greatly in excess of that hitherto fitted. This is due to the hot climate in which the ship will usually be serving. Part of this cooling capacity may be utilized in connection with the food stores.

A special feature of the turrets is the large space allowed for the operations. The gun-houses seem larger than usual. The side plating is in one piece, while the tops are in two pieces only, with a junction down the center. The front, being 12 inches thick, has had to be made in three pieces to form the gun ports.

The broadside armor amidships is 9 inches in thickness for a depth of over 22 feet 4 inches, 5 feet of which is below the normal load waterline. Forward and aft there is a transverse bulkhead, 9 inches thick, enclosing the barbettes. Forward and aft the waterline belt is reduced first to 6 inches and then to 4 inches at the ends. The upper strake amidships, extending to the top deck, is also of 9-inch armor, and within the citadel thus formed are the 4.7-inch guns on each side. There are two protective decks, the waterline deck being 2 inches thick and the upper one 1¼ inches thick. The 9-inch plates on their trial were subjected to three rounds, the striking energy in each case being 9,300 foot-tons. So satisfactory was the resistance to this attack that it was decided to fire a supplementary round, with a striking energy of 10,300 foot-tons. The result of this was exceptionally satisfactory, the penetration in no case being 2½ inches.

Mr. J. R. Perrett, F. R. S. N. A., the naval constructor of the Elswick firm, who was responsible for the design of the *Minas Geraes*, and who therefore deserves great credit for the increase in gun power, propulsive efficiency of the vessel and satisfactory disposition of the ordnance, must also be congratulated on the arrangement of the accommodation for the personnel, for which large provision had to be made. A study of the complement of the new Brazilian warships shows that the ratio as compared, for instance, with British ships, is as 7 to 5. Although this increase may not be proportionately so large in the case of officers, there is the fact that cabins are provided for a larger number of petty officers in the Brazilian fleet than in the British and other navies. As a consequence a greater number of staterooms had to be provided. All the officers are accommodated aft on the main and middle deck, and in view of the large range of temperature experienced in South America special care has had to be exercised to ensure healthy conditions. On both the main and middle decks there is a range of cabins on each side of the ship, and in the middle deck an innovation in warship design has been introduced by the adoption of double cabins, inner and outer. The public rooms, too, occupy the whole of the intervening space, the cabins opening direct on these public rooms. This was arranged at the instigation of the Brazilian authorities. There are obvious disadvantages with such an arrangement, notably the fact that the officers in the public rooms enjoying social intercourse may disturb the rest of their colleagues in the staterooms, while it is unavoidable that the companionways must lead direct into the public rooms. On the other hand, there is better ventilation, which in the hot climate of Brazil is an undoubted advantage. In addition there has been introduced the thermo-tank system of ventilation, ensuring a constant supply of air, heated or cooled, according to the atmospheric temperature prevailing, to every room and living space in the ship. Another feature is the adequacy of lavatory and bathroom accommodation. Indeed, so extensive is this that there is a probability that when the vessel is on service all the ordinary wash-tank basins will be dispensed with, as they are more or less a source of danger to health if the dirty water tanks are not immediately emptied. There is to be added also the luxury of the barber's shop, with its equipment for chiropody, etc. The sailors' quarters are also in advance of modern practice, and the sick bays have had very great care bestowed on their location and equipment.

The machinery was designed and constructed by Messrs. Vickers, Sons & Maxim, Ltd., of Barrow-in-Furness. The main engines are of the reciprocating type, and their adoption, notwithstanding the experience of the firm concerned with turbine machinery, is a fact to be noted. It is probably due to the desires of the Brazilian naval authorities. As the *Sao Paulo* and *Minas Geraes* will most frequently be run at low power, the cost of maintaining the ship in service will be very low. As regards vibration, the performance of the vessel at all speeds was very satisfactory, a consequence of the long experience of the builders of the machinery. The engines are of the four-cylinder, triple-expansion type, and the working parts have been proportioned to balance the couples. The diameters of the cylinders are: Thirty-nine inches in the case of the high-pressure, 63 inches the intermediate, and 73 inches for each of the low-pressure cylinders, all having a stroke of 3 feet 6 inches. The distribution of steam is controlled by a single piston valve in the case of each high-pressure cylinder, double piston valves being provided for each intermediate cylinder, and flat triple-ported slide valves for each low-pressure cylinder. The whole of the valves are actuated by valve gear of the double-bar Stephenson type, and the low-pressure valve gear is fitted, in addition, with Joy's patent assistant cylinders. Double-cylinder steam engines working "all-round" gear are fitted for reversing purposes, and similar engines are provided for turning the main engines. All the cylinders are separate and independent castings, each being fitted with a separate liner and steam jacketed. The cylinders

are supported at the front by wrought steel pillars, and at the back by cast iron columns carrying the guide faces. The bed-plates are of cast steel, the shaft bearings being of gun-metal, lined with white metal, and secured with wrought steel keeps. The crank and tunnel shafting is of forged steel and hollow. The propellers are three-bladed, the bosses and blades being of manganese bronze. The engines are arranged to run inwards when going ahead, the starting platform being in the center of the ship. One condenser is placed on the wing side of each engine-room. The total cooling surface is 24,000 cubic feet. The air pumps are of the independent twin type, and are placed one in each engine-room in the wings. This gives a very roomy compartment, with access to all parts. This is the more satisfactory as a large shell room and magazine is placed between the engine-rooms.

The boilers, eighteen in number, are of the Babcock & Wilcox latest type, and are arranged in three boiler rooms, the total heating surface being 58,370 square feet and the grate area 1,686 square feet. The supply of air to the stokeholds is provided by ten steam-driven fans. Weir's pumps supply the boilers with feed-water. Ash ejectors and the usual ash hoists are fitted in each boiler room, and there are air compressors for sweeping the boiler tubes and other services. A complete installation of evaporating and distilling plant is provided in each engine-room, while in a separate compartment, on the deck above, two cylindrical return-tube boilers provide steam for the auxiliary machinery throughout the vessel when the ship is in harbor.

The full speed attained with the *Sao Paulo*—21,623 knots—practically equals the average rate attained by the British dreadnought battleships, although special care had to be exercised in the design of the machinery in order that the steaming conditions might be easily met when using such coal as is readily available in South America, since this may not always be of the high calorific value of the better anthracites, and in order, also, to meet any deficiency in the skill of the stokers. Thus, for instance, the proportion of heating surface to grate area is about 36 to 1, as compared with from 30 or 33 to 1 in the British service. As a consequence, the boilers of the Brazilian ships are larger and heavier for a given power, but there is gain in greater reliability under the conditions of South American service. Reciprocating engines have been adopted and have proved of high efficiency, the radius of action, according to the results of the *Sao Paulo* trials, being 29 percent greater than that guaranteed, or 12,913 nautical miles instead of 10,000 at 10 knots. The full speed on trial—21.623 knots—was realized with 28,645 indicated horsepower, while the guarantee was for 21 knots. On a trial of about four hours' duration, during which six runs were made over the measured mile, a speed of 21¼ knots was attained with 25,517 indicated horsepower. On an eight hours' trial a speed of 20.99 knots was got with 22,355 indicated horsepower. There is thus the important advantage of a reliable high speed as well as a wide radius of action, added to offensive and defensive qualities of a high order, with a draft of only 25 feet, whereas in many of the later foreign dreadnought ships the design is for drafts ranging up to 29 feet and 30 feet. It is obvious that, especially in South American waters, the Brazilian ships must have a great tactical advantage in action. It should be remembered, too, that it is easier to find docking facilities where draft is thus limited.

As has previously been mentioned, the battleships *Minas Geraes* and the *Sao Paulo*, and the scouts *Bahia* and *Rio Grande do Sul* have been built from the designs prepared by Mr. J. R. Perrett, the chief constructor to Sir W. G. Armstrong, Whitworth & Company, Ltd., who also manufactured the armaments. The machinery was, however, manufactured and supplied by Vickers, Sons & Maxim, Ltd., Barrow-in-Furness; and when it is recalled that no two naval construction firms in the world have had an equally large experience in warship design and construction, it will be understood that this association has been to the great advantage of the Republic of Brazil. From first to last the performances of these ships in gun power, in thermo-dynamic, propeller and ship-form efficiency, and in maneuvering qualities have been most satisfactory, and the results must have afforded considerable satisfaction to his excellency Admiral Duarte Huet de Bacellar and the other officers of the Brazilian Naval Commission.

The Development of the Merchant Marine Shipbuilding in Japan.*

BY DR. S. TERANO AND M. YUKAWA

In 1853, when the American fleet, in command of Commodore Perry, appeared off the coast of Japan, the Shogun was surprised by the enormous size of the warships and awakened from the indolent dreams of the past. In 1854 a Russian man-of-war arrived at Shimoda, and was washed ashore by a tidal wave, and the Russians started to build a wooden schooner. This gave the Japanese the first opportunity of observing the construction of a European vessel. The first shipyard was started in Nagasaki in 1857. Dutch engineers and shipwrights were employed, and the machinery was from Holland. In 1861 permission to own large vessels was granted by the general public. The officers and crew for such vessels would be supplied by the government if desired. In 1862 the policy of closing ports to foreign trade was abandoned. In 1876 the site of the Ishikawajima, Tokyo, was leased to a private concern. This was the first private shipyard of modern type in Japan. The superiority of the Western type of vessel soon became thoroughly recognized.

Japan having no iron it was found more convenient to build small coasting vessels of wood; larger ones were all imported. Out of all, about 800 ships, both steamers and sailors, built from 1870 to 1884 were of wood, the maximum size being 500 tons.

The government in 1900 issued a code of regulations for the construction of wooden ships. This had a remarkable effect in improving them. In the early seventies a few iron ships were built, one, the *Asahi Maru*, of 406 tons gross, and this was followed by three others. The first steel vessel, the *Chikugogawa Maru*, 664 tons, was laid down in 1890 in Nagasaki. In 1895 the *Suma Maru*, of 1,592 tons, was launched. She was the largest merchant ship built prior to the "Shipbuilding Encouragement Act," and was the first ship fitted with complete cellular double bottom. In 1883 appliances for repairs were scarce. It was recognized that subsidies should be granted for shipyard extension; but the difficulties were still unsettled when, in 1894, the Japan-China war broke out. The number of merchant ships available for war purposes was very considerable, but the withdrawal of 240,000 tons from the trade of the country threatened serious difficulties. The victorious ending of the war caused the commerce industry of the country to expand enormously. The protection and encouragement of shipbuilding were deemed necessary, and during the ninth session of the Imperial Diet bills for the encouragement of navigation and shipbuilding were passed with overwhelming majorities. The rules for ship construction to accompany the "Encouragement Act" came into force in September, 1896, and were the first Japanese rules for shipbuilding. The law for the encouragement of navigation showed a remarkable result. The number of ships was doubled and the tonnage trebled.

* Abstract of paper read at the Jubilee Meeting of the Institution of Naval Architects.

The first ships built under the "Encouragement Act," the *Iyo Maru* of 727 tons, launched in 1897, and the *Hitachi Maru,* became famous on account of being torpedoed and sunk in the Russian war. Since that time the "Encouragement Act" has gradually increased the ships of Japan. The Russian war, in 1904, resulted in a large number of merchant steamers being again taken up for transport service; in consequence, the shipping trade of Japan was in danger of being actually stopped, and during the war both the government and private yards were so busy with repairs that not much work was done with new construction.

The *Tango Maru,* of 7,400 tons, was launched in 1904. After peace was established, the fever for public enterprise came on, and extensive schemes for the expansion of the fleet were carried out. The passenger service between San Francisco, Japan and China demanded faster and better-equipped ships, and an order was placed for three 20-knot passenger steamers of 13,500 gross tons each with the Mitsu-Bishi Works. These boats were turbine-driven and made an average speed of 20.6 knots. The European service was improved by the addition of six steamers of 8,600 tons each and 16 knots speed. The total amount of subsidies paid has increased year by year, in proportion to the advance of shipbuilding, and the progress of the industry has thus been largely due to the assistance from national funds. The original fishing boats of Japan were junk-built and unseaworthy, but the "Encouragement Act" was amended with the object of improving them, thus enabling the Japanese fishermen to go out in the open sea; but the most noteworthy event in fishing boats is the adoption of oil motors.

The first marine engines built in Japan were constructed in 1861, a geared horizontal non-condensing engine with two cylinders 16 inches in diameter and 15⅞ inches stroke. The first compound was built in 1873, with cylinders 12 inches, 21 inches and 18 inches stroke. Triple-expansion engines were introduced in 1880 by purchase from England, and the first one was built in Japan in 1890 at the Mitsu-Bishi Works. Quadruple expansions were few, the first one being built in 1902. The Kawasaki Dockyard Company, at Kobe, is licensed to build the Curtis marine turbine, and is now constructing some for the Imperial navy.

Up to 1887 only iron boilers were built in the country. The first steel boiler was for the tug *Yugawo Maru,* 206 tons, the pressure being 180 pounds. Watertube boilers have not yet been used in the Japan mercantile service except for the volunteer fleet.

The number of private yards has increased from 66 in 1896 to 213 in 1910; the majority, however, are very small, and only capable of building wooden sailing ships or junks. A few are provided with modern appliances. In the matter of equipment, the principal shipyards are equal to first-class firms in Europe and America.

Ships of over 1,000 gross tons were divided into two types—passenger and non-passenger, which were again sub-divided into four classes—ocean service, home trade, coasting trade and smooth-water service—and the subsidies varied according to the respective classes. The machinery bounty is the same in all classes. The necessity of promoting the iron and steel industry was recognized and the government steel works was established in 1898. It is capable of producing 100,000 tons of steel a year. The cost of production and the selling price, however, leave a good deal to be desired, and the builders still import foreign material. It will take some time before Japan can become self-supporting in the shipbuilding industry.

The Bureau of Navigation reports ninety-three sail and steam vessels of 11,999 gross tons were built in the United States and officially numbered during the month of November, 1911, of which 7 percent were steamships.

Fifty Years' Development in the Mercantile Ship Construction.*

BY S. J. P. THEARLE

In 1857 the *Great Eastern* was built at Millwall by Mr. Scott Russell. She was 679 feet 6 inches long, 82 feet 8 inches by 31 feet 6 inches. Had there been no *Great Eastern* the progress of mercantile shipbuilding in the fifty years of the Institute's existence would have shown gradual development throughout. It is only fitting that an institution which owes its existence largely to the energy, foresight and scientific ardor of Scott Russell should in its fifty-first year bear testimony to the genius of that great man. In the year 1860 the mercantile marine of the United Kingdom consisted of 27,663 vessels, of 4,658,687 tons net register, by far the greater part being of wood. Of the total tonnage in 1860, 25,663 vessels, of 4,204,360 tons net, were propelled by sail, and 2,000 vessels, of 454,327 tons net, were steamers. At the end of December 1909, the merchant ships consisted of 21,189 vessels of 11,585,878 tons net, or 18,402,201 tons gross register. Of these, 11,797 vessels, measuring 10,284,818 tons net, or 16,994,732 tons gross, were steamers. There were 9,392 sailing vessels, of 1,301,060 tons net, or 1,407,469 tons gross register. It will be seen there were 6,474 more vessels in 1860 than there were in 1909, but the tonnage showed in forty-nine years an increase of 6,927,191 tons. To better realize the expansion which has taken place, the gross in steamer tonnage was from 454,327 tons to 10,284,818 tons, while the reduction in sailing tonnage was from 4,204,360 to 1,301,060 tons. We compute a ton of steamer tonnage as at least equal to 3 tons of sailing tonnage. In point of fact the ratio is even greater than 3 to 1, and is constantly increasing; but taking 3 to 1, the ratio of cargo-carrying capacity in 1909 compared with 1860 is as 32,155,514 to 5,567,341, or almost 6 to 1. The average tonnage of sailing vessels in 1860 was 164 tons and that of steamers 227 tons. The average tonnage of cargo steamers in 1870, 1880, 1890 and 1900 was, respectively, 870, 1,330, 1,500 and 1,900. In 1911 the average tonnage was 2,300. The average gross tonnage in the above years was, respectively, 1,050, 1,580, 2,150 and 3,000. The average gross tonnage of cargo steamers built in 1910 was rather more than 3,000. In 1860 the average length of cargo steamers was under 200; in 1911 it had reached 350 to 400 feet.

Lloyd's Register Rules in 1855 for building made the classification of iron vessels in terms of years. In 1863 "A" symbols were used. In 1867 the designation was by numerals, as "100-A, 95-A," etc. In 1860 the frame of an iron ship was formed of an angle-iron and a reversed angle riveted back to back. Beams were formed of plates with double half-round irons on the lower edge and double angles on the upper edge. With the advance in iron rolling a bulb plate took the place of the double bar or half-round section. The box "keelson," which was inaccessible, gave way to a built-up keelson formed of plates with double angles on the upper and lower edges, and this construction still survives. In 1867 water ballast tanks began to form part of the bottom structure. It was not, however, until 1880 that the cellular double bottom in anything like its present form appeared in the mercantile marine, although something like it had been adopted earlier in the ships of the Royal navy, without, however, the characteristic feature of the margin plate at each bilge, with its frame attachment, which then and now is a peculiar feature of the merchant steamer. In 1889 two of the largest and fastest vessels of the Atlantic passenger trade were constructed without double bottom, with ordinary floor and shaped keelson standing upon them. Gradually it was realized that without outer

* Abstract of paper read at the Jubilee Meeting of the Institute of Naval Architects.

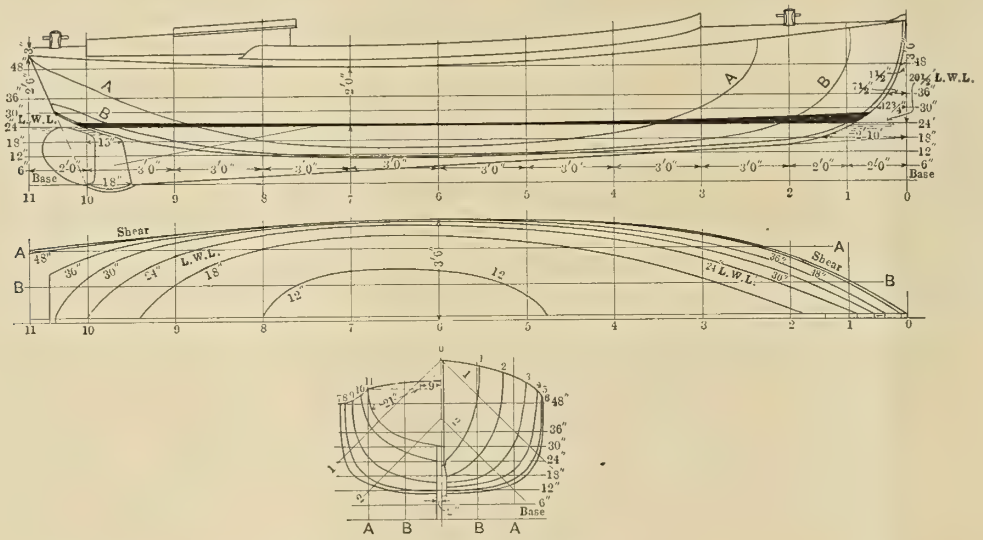
and inner bottom plating, associated with a continuous center girder, continuous margin plates and well-fitted intercostal side girders, there was ample longitudinal strength in the bottom, and the continuous floors associated with intercostal side girders were found to be a more rapid and cheaper construction than any other. The necessity for carrying a certain quantity of water ballast had much to do with fixing the depth of the floor and girders and strength requirements. During the past fifty years bottoms have probably undergone as great a change as any other part of the vessel, and this has specially been the case during recent years.

In regard to recent developments in the structure of merchant vessels, the tendency to omit angle side stringers in holds and to compensate for their omission by increasing the thickness of the shell plating is noticed. Not only does this not detract from the strength of the structure, but it has the advantage of cheaper production, and there is a growing disposition to increase the frame spacing and thickness of shell plating. The joggling of either plate edges or frames is in practice at all ports. In 1860 the pillaring of an iron ship followed the same principle that had been used in vessels of wood, though not being so broad as to require more than a middle line row to the beams clear of the hatchway. As vessels became broader a row of quarter pillars was introduced. The first progressive step in this direction was made when tubular pillars were introduced. Their expense, however, is almost prohibitive. "Massed pillaring" arrangement, in which support to the deck is afforded by a few very strong pillars, came next.

The stiffening of watertight bulkheads has undergone many changes during fifty years. In 1860 the only stiffening to watertight bulkheads consisted of angle-bars spaced about 30 inches apart. Before the bulkhead committee appointed in 1891 sat, the committee of Lloyd's Register had increased the stiffening requirements by making the vertical stiffeners of frame angle size and by fitting horizontal stiffeners. For years after iron ships were built they were fitted with wooden decks. With increased size grew the necessity of providing strength in excess of that which was obtainable through stringers and tie plates, and iron decks were found to be a necessity.

Recent years have witnessed many important departures in steel ship construction. The first to claim attention were the "turret" steamers introduced by Messrs. Doxford & Company. The advantage of the "turret" system is a larger deadweight carrying capacity. The "trunk" steamers were introduced by Messrs. Ropner, and were chiefly used for conveying ore and grain. The cantilever frame wing tank steamers of Messrs. Sir Raylton Dixon & Company followed, and it is regretted that the Institution of Naval Architects has no record of this type of vessel; and this may be said of the McGlashan side-tank steamer. Probably the most interesting of all recent developments in ship design is that of Mr. Isherwood, which involves longitudinal framing. Upward of ninety of these vessels, with an aggregate of 356,000 tons, have been ordered.

To do full justice to the subject of this paper, however, notice should be made of the composite system of construction between 1860 and 1870. This system combines the strength of iron frame work partially plated with the advantage of wooden skin to receive copper sheathing. The performance of the composite tea clippers will long be remembered. The system, however, an expensive one to build, was found liable to special forms of deterioration, chiefly associated with galvanic action.



LINES OF A NEW 30-FOOT FREIGHT LAUNCH

Thirty-Foot Freight Launch.

A 30-foot freight launch has been designed by Tasker & Strawbridge, Philadelphia, for James Murphy & Sons, Placentia, N. F. The boat is 30 feet long over all, with a load waterline length of 26 feet 3½ inches. The extreme beam is 7 feet molded, and the width on the load waterline 6 feet 6 inches molded. The freeboard runs from 3 feet 6 inches at the bow to 2 feet amidships, and 2 feet 6 inches at the stern. The extreme draft is 2 feet.

The keel is constructed of oak 4 inches thick, sided 5 inches, and the framing is of sound white oak 1¼ inches square. White oak is used for the shear strake, which is 1 inch thick, and the planking is of ⅞-inch white pine, copper fastened throughout. The deck beams are 1¼ inches by 3 inches of oak. The decking itself is of quartered white oak, laid fore and aft, blind fastened.

The cockpit is sealed up on the inside with ⅜-inch spruce. The gasoline (petrol) tank and watertight lockers are located under the forward deck. There is a sliding companionway over the motor in the stern, with lockers aft of the motor compartment. The flooring throughout the launch is put down to facilitate the cleaning of bilges. An ordinary steering wheel and drum are provided actuating a bronze or galvanized iron rudder. The gasoline (petrol) tank is of 35 gallons capacity, fitted with two interior bulkheads to prevent swashing of the oil in a seaway. It is proposed to install a 7 to 10-horsepower, medium or heavy duty, high-grade engine for propulsion.

Repair Plant on Board the U. S. Battleship Georgia

Among recent improvements in the equipment of battleships one of the most important is the installation of repair plants, so that a great amount of the repairing can be done on a vessel without recourse to a navy yard, making the vessel in a measure self-supporting. The repair plant of the *Georgia,* which was installed after the vessel was in commission, was described in the August issue of the *Journal of the American Society of Naval Engineers,* of which the following is an abstract:

FIG. 1.—GENERAL VIEW OF FOUNDRY

The foundry is situated on the upper deck, and is in a small deck-house abaft the after funnel. It contains a Mircs combined blacksmith's forge and melting furnace, capable of taking a No. 70 crucible; a bin with one-half ton of Albany sand; several flasks, iron and wood, and other foundry acaccessories, such as tongs, shanks, clamps, etc. The largest casting made up to date weighed about 175 pounds with riser and gate. Since its installation a year ago the foundry has turned out over 800 castings of all sizes. Oil fuel is used for melting metal. Albany sand is used, as practically none but brass castings are made. Iron castings can be made in emergencies, but the crucibles when melting iron last only a very short time. It has been found that the foundry has been the greatest asset to the repair plant of the ship, since much of the machine work formerly done at a navy yard is now done on board on account of the fact that castings can be made on board.

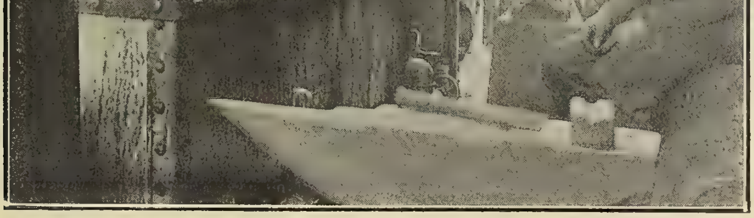


FIG. 2.—BLACKSMITH'S SHOP

The blacksmith shop is situated in a small deck-house on the upper deck between the two forward funnels. A large rectangular double forge is installed, capable of handling 4½-inch bars. A small ¼-horsepower portable electric blower furnishes ample blast for both fires. The fires are also used by the coppersmith for large brazing jobs. The small space in the trunk to forced draft blowers is used as a copper shop. All the small work is done here, while the heavier work is done either in the foundry or in the blacksmith shop. This enables most of the copper work to be kept in repair and necessary changes to be made. For the carpenter's shop it was found necessary to use a forward compartment on the port side of the gun-deck. Besides heavy carpenters' benches a speed lathe and circular saw, driven by a 3-horsepower electric motor, are installed. Beside the carpenter's shop is a

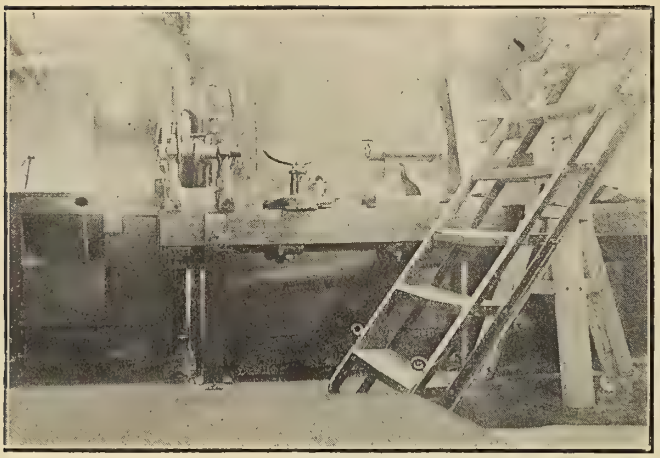


FIG. 5.—CIRCULAR SAW AND SPEED LATHE

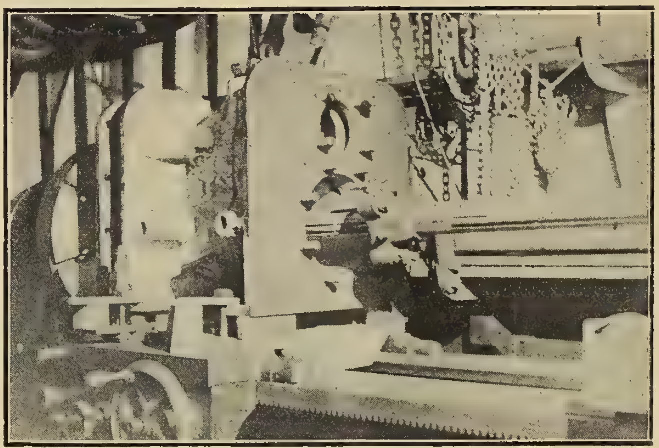


FIG. 6.—BORING 100-K.W. DYNAMO CYLINDER

plumber's shop, the equipment of which consists largely of hand tools.

An important part of the outfit is the machine shop, which is located directly underneath the evaporator room, just abaft the fire-rooms and just forward of the upper engine rooms, or in what is probably the hottest part of the ship. The equipment includes a large gap lathe with 54-inch swing; a 14-inch Flather machine lathe; a 16-inch by 12-foot Hendey-Norton tool-room lathe; a No. 14½ Becker-Brainard universal milling machine with vertical attachment; an 18-inch shaper; a 28-inch drill press with a 12-inch sensitive drill. All these tools with one exception are driven by one large shop motor through belts and countershafts. The Hendey lathe has an independent motor drive, and has been found the most valuable tool in the shop.

The value of such repair equipments on board a ship are evident from the fact that at the first repair period for the *Georgia* the only work to be done in the engineering department by the navy yard was the manufacture of two castings for the ash ejector system and re-bushing the stern bearings. All other work was done by the ship's force on the ship.

DUCHESS OF RICHMOND

Railway Steamer Duchess of Richmond

We present herewith a picture of the paddle-wheel steamer *Duchess of Richmond,* built for the Portsmouth and Isle of Wight service of the London, Brighton & South Coast Railway Company. The vessel was built by Messrs. D. & W. Henderson & Company, Ltd., at their historic yard at Meadowside, Glasgow. She is of a handsome model. Her dimensions are 198 feet by 26 feet by 9 feet molded. She is fitted up with the most up-to-date appliances in every department, including a complete installation of electric light. The accommodation for first class passengers is aft, the drawing-room being on the main deck and the dining saloon on the lower deck. The second class accommodation is forward, and is very comfortable.

The engines are of the compound diagonal type, with cylinders 27 inches and 51 inches diameter and 54 inches stroke. The boiler is double-ended, of the multi-tubular type, working at a pressure of 130 pounds. It is 12 feet 3 inches diameter and 17 feet long, and has four furnaces. All the piping is of copper and Bryce's patent coupling is used wherever possible. The high-pressure cylinder of the main engine has a piston valve, and the low-pressure a slide valve. The pistons are conical in shape, and are fitted with suitably supported packing rings. The guide bars, cross-heads, piston and connectng rods are of forged steel, as is the valve gear. The working parts are of phosphor bronze. The guide shoes and crank-shaft bearings are of cast steel. The guide shoes are white metal, lined, and the shaft bearings have gunmetal bushes. The crank-shaft is of forged steel with couplings at the ends. The two webs and crank pin for each engine are forged together and shrunk on the shaft. The air pump is Edwards' patent, and the circulating pump is centrifugal, supplied by Allen, of Bradford. The surface condenser is of cast iron, and supports the main bearings; it has an ample surface in the tubes, tinned on both sides, which are ¾ inch diameter. The auxiliary machinery consists of a pair of pumps and float tank, by G. & J. Weir, of Glasgow, and a duplex pump by Lamont. The steam reversing gear is that of Messrs. Brown Bros. The propelling machinery operates a pair of feathering paddle-wheels, having eight curved steel floats in each wheel. The steam is supplied at a pressure of 130 pounds per square inch, and on trial the vessel gave a very satisfactory performance.

Preliminary Census Report of United States Shipbuilding

A preliminary statement of the general results of the thirteenth census of establishments engaged in shipbuilding has been issued by Director Durand, of the Bureau of the Census, Department of Commerce and Labor. It includes the operations of shipyards building steel and wooden steam, sail and unrigged vessels; yachts, motor boats, rowboats and canoes; and the manufacture of masts, spars, oars and rigging. The report contains summaries showing the general statistics of private shipyards and of government shipyards separately, and the number, kind and tonnage of all vessels launched in 1904 and 1909. It was prepared under the direction of William M. Steuart, chief statistician for manufactures, Bureau of the Census. The figures are subject to such revision as may be necessary after a further examination of the original reports.

Rates of Increase

The general summary for private shipyards shows increases in six and decreases in five of the items at the census of 1909, as compared with that for 1904.

The number of establishments increased 23 percent; capital invested, 4 percent; number of salaried officials and clerks, 20 percent; amount paid in salaries, 21 percent; miscellaneous expenses, 33 percent; primary horsepower, 13 percent.

The value of work done during the year decreased 11 percent; cost of materials, 17 percent; value added by manufacture, 7 percent; average number of wage-earners employed during the year, 20 percent; amount paid for wages, 14 percent.

There were 1,353 establishments engaged in this industry in 1909 and 1,097 in 1904, an increase of 23 percent.

The capital invested as reported in 1909 was $126,118,000 (£26,000,000), a gain of 4 percent over 1904. The average capital per establishment was approximately $93,000 (£19,000) in 1909 and $111,000 (£22,800) in 1904.

Value of Work Done

The value of work done at private shipyards during the year 1909 was $73,360,000 (£15,000,000), a decrease of 11 percent from 1904. The average per establishment was approximately $54,000 (£11,000) in 1909 and $75,000 (£15,400) in 1904. The decrease in value is due to the dismantling of a large shipyard in Connecticut after the completion of the *Minnesota* and *Dakota;* to a decrease in construction in Pennsylvania, and to a reduction of output in one large establishment in California. The work in the establishments referred to in the last-named States was largely for the government in 1904.

The cost of materials used was $31,214,000 (£6,400,000) in 1909, a decrease of 17 percent since 1904.

The value added by manufacture was $42,146,000 (£9,060,000) in 1909 and $45,306,000 (£9,320,000) in 1904, a decrease of 7 percent. This item formed 57 percent of the total value of products in 1909 and 55 percent in 1904. The value added by manufacture represents the difference between the cost of materials used and the value of products after the manufacturing processes have been expended upon them. It is the best measure of the relative importance of industries.

The miscellaneous expenses amounted to $7,004,000 (£1,440,000) in 1909 and $5,256,000 (£1,080,000) in 1904, an increase of 33 percent.

The salaries and wages amounted to $29,303,000 (£6,025,000) in 1909, a decrease of 10 percent since 1904.

The number of salaried officials and clerks was 2,980 in 1909 and 2,480 in 1904, an increase of 20 percent; their salaries increased from $3,340,000 (£686,000) in 1904 to $4,035,000 (£830,000) in 1909, or 21 percent.

The average number of wage-earners employed during the year was 40,506 in 1909 and 50,754 in 1904, a decrease of 20 percent; their wages decreased from $29,241,000 (£6,000,000) in 1904 to $25,268,000 (£5,200,000) in 1909, or 14 percent.

Government Shipyards

The general summary for government shipyards shows increases in all the items at the census of 1909 as compared with that for 1904.

The value of work done during the year increased 50 percent; cost of materials, 42 percent; value added by manufacture, 55 percent; average number of wage-earners employed during the year, 19 percent; amount paid for wages, 36 percent; number of salaried officials and clerks, 233 percent; amount paid in salaries 279 percent; miscellaneous expenses, 219 percent.

Decrease in Total Number and Tonnage

The statement of kind, number and tonnage is not that of vessels begun or advanced toward launching, but only of vessels launched, which may happen to be less numerous and important during the census year than those on the ways. Fewer ships were launched and the tonnage was less in 1909 than in 1904.

The aggregate number of vessels of all kinds of 5 tons and over launched at private and government shipyards, together with those launched by establishments engaged primarily in the manufacture of foundry and machine-shop products, steam railroad cars and lumber and timber products, was 1,637 of 481,813 gross tons in 1909, compared with 2,279 of 553,599 gross tons in 1904. This is a decrease of 28 percent in number, but of only 13 percent in gross tonnage, the average tonnage per vessel increasing.

Of this aggregate, the number launched at private shipyards of concerns primarily engaged in shipbuilding during 1909 was 1,584, compared with 2,114 in 1904, a decrease of 25 percent. The gross tons totaled 467,219 in 1909 and 504,020 in 1904, a decrease of 7 percent. The net tonnage decreased from 424,708 to 381,198, or 10 percent.

The number launched at government shipyards was 31 both in 1909 and 1904. The gross tonnage was 2,059 in 1909 and 27,252 in 1904, a decrease of 92 percent, indicating that the average vessel launched was very much smaller than in 1904. No battleship was launched from a government shipyard in 1909; the *Florida,* under construction, was not launched until 1910. The battleship *Connecticut* of 16,000 tons displacement and two steel training barks of a combined gross tonnage of 3,600 were launched in 1904. This accounts for most of the great decrease in tonnage at government shipyards.

There were launched in 1909, 22 vessels of 5 tons and over having a gross tonnage of 12,535, and in 1904, 134 with a gross tonnage of 22,327, by establishments engaged in making such articles as steam railroad cars, foundry and machine-shop products and lumber and timber products.

Character of Vessels

The aggregate of steel vessels was 169 in 1909, having 260,765 tons compared with 175 in 1904 having 178,572 gross tons, a decrease of 3 percent in number and an increase of 46 percent in tonnage. The aggregate number of wooden vessels of 5 tons and over launched at all shipyards in 1909 was 1,468 of 221,048 gross tons, compared with 2,104 in 1904 of 375,027 gross tons, a decrease of 30 percent in number and 41 percent in tonnage. Of boats of less than 5 tons the aggregate number in 1909 was 9,042, and in 1904, 3,916, a gain of 131 percent. All these statistics include vessels built by government yards and by concerns not primarily engaged in shipbuilding.

Letters of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Walschaet Valve Gear

The Walschaet or Heusinger von Waldegg valve gear is a type of radial gear which is seldom fitted to marine engines. It is, however, being extensively adopted by the Pennsylvania Railroad and others.

The arrangement of this gear is shown in Fig. 1, and is as follows:

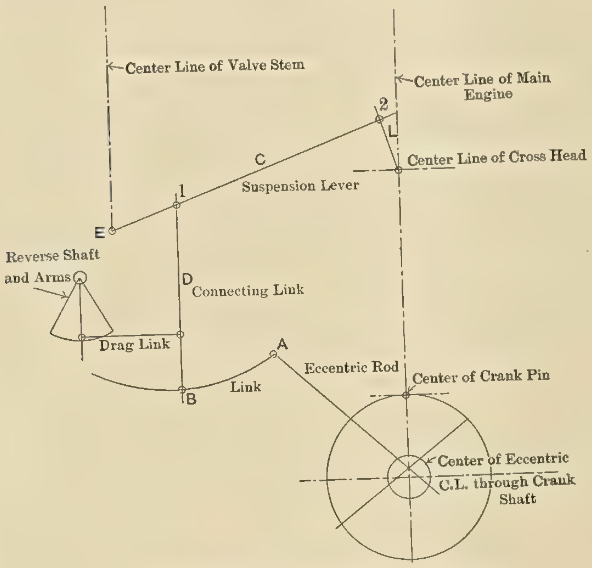


FIG. 1.—SKETCH OF WALSCHAET VALVE GEAR

An eccentric is keyed to the crankshaft at an angle of 90 or 180 degrees. The eccentric rod engages at its end *A* a link, which rotates about the center *B*. The link block connects to the suspension lever *C* by a link *D*. The end of the suspension lever is driven direct from the crosshead of main engine through the medium of links *L*. The valve stem is connected at *E* at other end of suspension lever. The sketch shows arrangement for outside steam. If inside steam, then valve stem is between the points 1 and 2.

The indicator diagrams shown in Fig. 2 were taken from a marine quadruple-expansion engine fitted with this gear. These diagrams were taken some months before the writer was called in on some consultation work, and are very poor specimens. Upon examining these diagrams the first thing that fixes attention is the poorly designed reducing motion, which is very crude, yet it was furnished by the builders of this vessel. The steam distribution is bad, and is due in part to poor proportions of the valve gear. The cut-off is even slower than with the ordinary link motion.

Diagrams of Fig. 2 were taken when the engine was making 138 turns. These diagrams are very interesting, and are remarkable examples of poor design and adjustment of this type of gear. With a properly designed gear and adjustment of valves, and with proper reducing motion, the diagrams will be very different. I do not mean to infer that the diagrams are not correctly taken, but the design throughout in this case is very poor.

Looking now at the diagrams shown in Fig. 3, we see perfect diagrams taken from a locomotive fitted with this type of gear, showing the advantages and serviceability of this type of gear. In a correctly designed arrangement these diagrams are characteristic, and a comparison of these diagrams with those taken from engines fitted with Stephenson's link are worthy of close and careful perusal. CHARLES S. LINCH.

Temporary Repair of an Atlantic Liner's Thrust Shaft

EDITOR INTERNATIONAL MARINE ENGINEERING:

We were on our usual run across the Atlantic, west bound, with about 2,000 sacks of mail, and somewhere over a thou-

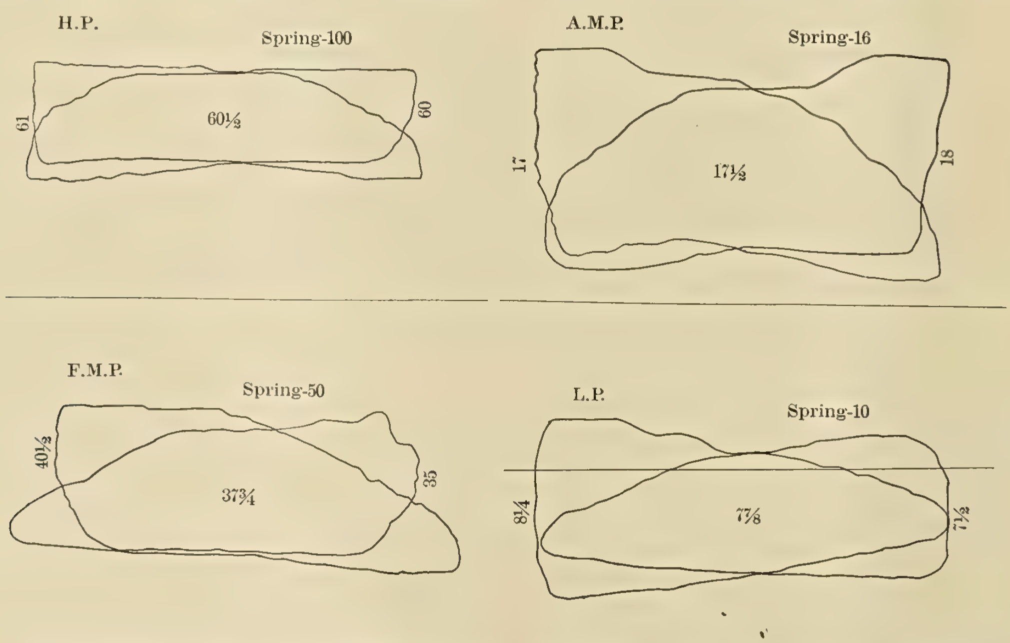


FIG. 2.—INDICATOR CARDS FROM QUADRUPLE-EXPANSION MARINE ENGINE FITTED WITH WALSCHAET VALVE GEAR

sand passengers. As a matter of fact, the accident I am going to write of happened when we were about four and one-half days' run out from Queenstown. It happened on the steamship "U——," and it was while one of the engineers was on watch and noticed that several of the thrust block rings were moving about in an unusual manner that we first began to notice anything was wrong.

A careful watch was set on the thrust block rings, and after some time the movements of the rings not becoming any worse we began to think that matters were not really so bad as we had at first thought them to be. However, shortly after we had eased our minds a bit the ship gave a very sudden and big lurch to port. This didn't seem to improve matters at all around the thrust block, and so after a great deal of wondering what was best to be done we stopped the engines, and it was then, on making an examination of the shaft, that we found it was broken.

We found a fracture extending along the neck close to a collar for three-quarters way round the circumference, then diagonally fore and aft to the next collar, and then back round the circumference for a short distance in the opposite direction. Adjoining each collar we found the cracks opened very much. At this time the ship was about one and one-half to two days' ordinary steaming from New York, the port for which we were bound. We decided that, as we were only such a distance from port, and as the weather was good, that we would effect only a temporary repair, and then proceed under easy steam to port.

The repairs were made in the following manner: In order to bind the shaft together endways, three holes were drilled in each of the collars next to the fracture, and then we put coupling bolts through them and drew them up as tight as we could. We next passed a strong clamp round the body of the shaft between the collars, and around the neck and the collars two straps were passed to secure the whole. We decided to guard against the shaft falling should the repairs give out. We supported the end of the shaft next the fracture from the deckbeams by a chain sling and stretching screws, the shaft revolving in the bight of the sling. The repairs took us four and one-half days to complete, and we then made a start under easy steam; but, after working for four and one-half hours, we had the misfortune to break one of the bolts.

We had now to stop the engines again and start in and repair this broken bolt, and, I might say, this job took us twenty hours' hard work. This completed, we started up the engines again at a nine-knot gait; at this speed the repairs showed no weakness, so we increased the speed to twelve knots, which enabled the ship to reach New York about six days late. It is needless to say we had a new shaft in New York. F. J. S. N.

Camden, N. J.

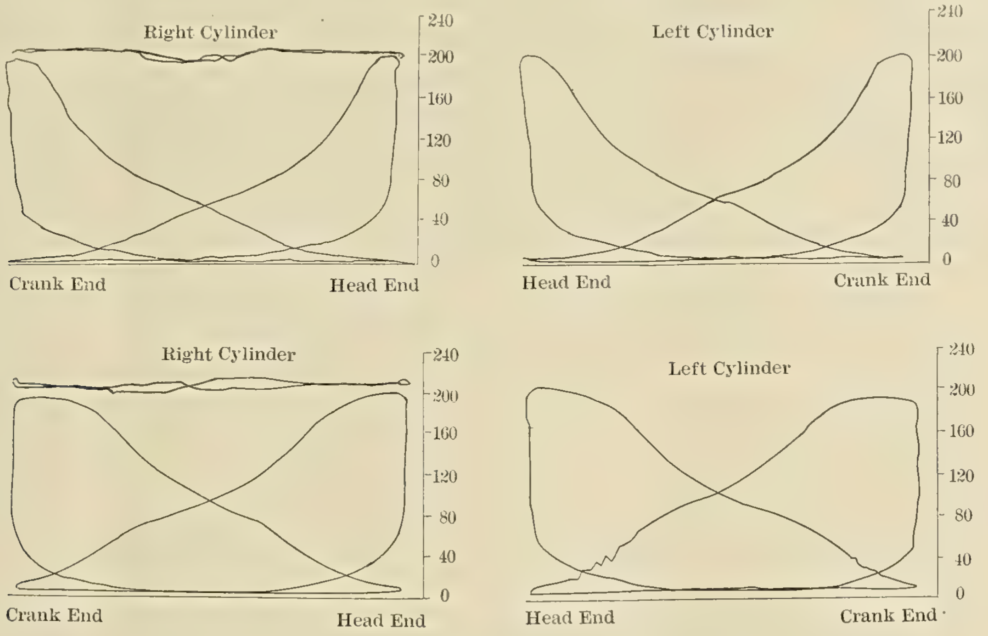


FIG. 3.—PERFECT INDICATOR DIAGRAMS FROM LOCOMOTIVE EQUIPPED WITH WALSCHAET VALVE GEAR

A Series of Accidents

It has sometimes been said that sea-going men are superstitious. The best answer to that is probably that even the matter-of-fact individuals in comfortable offices who suffer the smile of scorn at the mariner to irradiate their features, would possibly develop a touch of imagination—or nerves—if they were put face to face with some of the more exciting episodes of a seagoing engineer's life. It is very easy almost to believe in the personality of machinery at times when the engines are doing battle with the elements, and also when everything on board seems to be "going wrong."

It was not, however, with the object of developing a new theology that this article was commenced, but rather to describe a series of engineering incidents which can be classed as extraordinary. Some years ago a tramp steamer was making a run between Gibraltar and Malta in rather rough weather. A few hours out it was noticed that the engine speed slowed down from about seventy-five to fifty revolutions, although valves were full open and full steam was carried. There was no external trouble to account for this, but a dull thudding was heard in the engine. This was located in the low presure line, and by listening at the cylinder the thudding and clicking could be distinctly heard.

A repair at sea was out of the question in such heavy weather, so that it was decided to run on to Gibraltar, and the number of times that the engineer on watch placed his ear against that low-pressure cylinder was remarkable. Nothing startling occurred, however, till harbor was reached and the order came from the bridge to go half-speed. No sooner had the engines been slowed down than it seemed as if they would push their way through the bottom of the boat. The noise in the cylinder was that of a power hammer, and everybody stood ready to jump. The engineers held to it, however, but when the order came to stop the engines for a moment

to let another craft pass, it was impossible to start again and the anchor had to be dropped right there.

When the low-pressure cylinder cover was lifted the pleasing fact was discovered that the piston had broken clean in halves, as shown in the sketch, Fig. 1. The way in which the two halves kept together was almost a miracle; it was probably due partly to the fact that the piston was a deep one, partly because the crack across the top web was at an angle to the

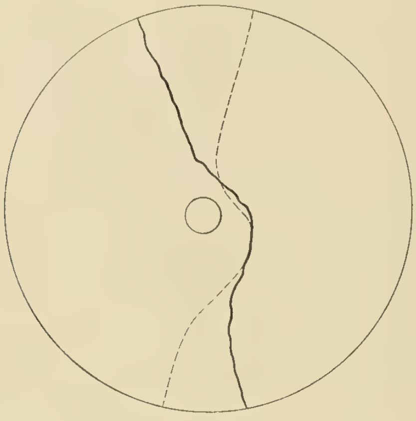


FIG. 1

fracture in the lower web, and partly also because the piston rings acted to some extent as straps. The engineers had a little quiet reflection, however, on the number of times their ears had been in close proximity to danger during the voyage.

As there were means of repair, none too extensive, at Gibraltar, the owners of the boat were wired as to whether they would allow the boat to lie up till a new piston rod could be dispatched from Great Britain, or whether a repair should be attempted on site. The reply was to the effect that too much delay would be caused by getting the repair from home, and that Gibraltar had better do its best.

A new piston head was therefore cast and machined from the old one, and duly delivered on board. The fit appeared to be good, but almost as an afterthought, and just as the cylinder cover was about to be tightened down, the chief engineer decided to have the engine barred round. The curious result was obtained that, on the top of its stroke, the piston lifted the cylinder cover ⅜ inch off the flange at the joint, and on examination it was found that the coning of the hole had

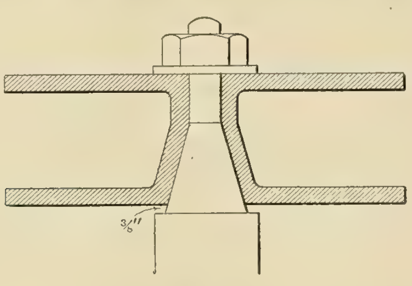


FIG. 2

not been sufficiently deep, so that the piston did not come down to its solid position by ⅜ inch, as seen in Fig. 2. An informal vote of thanks was given by the chief engineer to himself for having thought of barring the engine round, and pious hopes concerning the future welfare of the foundry people on shore were expressed.

The coned hole was cleaned out so that the piston was let down another ⅜ inch, and as this left no clearance between the head of the piston and the top of the cylinder, and as the metal at the top of the piston head was amply designed, a further depth of ⅜ inch was turned off the piston head. As a further precaution, a piece of thick lead sheeting was interposed between the top flange of the cylinder casting and the corresponding flange of the cover.

It must be remembered that all this time the boat was urgently wanted, but the various repairs had taken up a period of three weeks. The last part of the performance was finished at high pressure, and after the engine had been first barred round, and afterwards turned over slowly by steam, the chief engineer gave all hands half-an-hour for tea before setting the engines away for the trip. The engine had turned over quite easily, and everything at last seemed in order. When tea was over, however, and an attempt at a start was made, the engine would not budge. It took the united efforts of the engine room crowd and the steam starting engine to get her over a turn or two. Then, just when it seemed necessary to pull everything down and start a general overhaul, the engine gave a jerk and then went ahead quite smoothly.

The inner meaning of this last phenomenon was not discovered until the vessel had been some hours on her voyage. It was then found that the boilers were gaining water very rapidly, and a test with the salinometer showed that salt water was getting in very freely. The boat was therefore stopped and the condensers opened out. It was then found that a considerable number of the wooden ferrules which should hold the tubes in the tube plates had disappeared, and a lot more were loose. The three weeks' rest in the hot climate of Gibraltar had dried them and shrunk them up, so that at the resumption of work they dropped out and opened up practically free communication between the steam and the water. As the weather was calm, the boat was kept stopped until fresh ferrules had been put in, after which the boat ran perfectly normal. This, however, explained the bad starting of the engine. Both the auxiliary barring engine and the main engine exhaust passed to the condenser, and, in barring over the main engine (and still more when steam was opened up onto the main engine itself for the purpose of turning over slowly) a vaccum was formed in the condenser, drawing seawater into the steam space. When the engine was shut down for the half-hour tea time, this water gradually drew up into the cylinder of the barring engine and also the low pressure cylinder of the main engine. It was not until all this water had been cleared out by hard work that the engine was free to run.

This experience, viewed retrospectively, has its humorous side, but it would probably be hard to beat it as a succession of mechanical failures treading so closely on each other's heels.—*American Marine Engineer.*

Economy from the Stokehold

Editor International Marine Engineering:

There is at present quite a discussion as to the relative merits of the reciprocating engine versus turbine. The writer frankly admits that not enough scientific consideration is given to the design of the multiple cylinder engine, while the turbine is of necessity a machine where thermodynamic principles must be studied. There is one thing in designing an engine where every refinement may be introduced, and refined tests made, after same has been built and installed, but it is up to the engineer of the ship to so work his plant that the same or even greater economy may result. The most important thing, however, is the boiler plant. It is only a waste of time to point out what is evident to many sea-going engineers, viz., poorly designed pipe plans, etc. In any argument there is one thing that must be borne in mind: the designer may design for certain results and the design may be good, but when the plant is put into the hands of the engineering force aboard ship, it is up to them to show results.

To illustrate my assertions: One day, coming out of Sa-

vannah, on the steamer "R——," I was leaning against the rail looking up at the smoke pouring out of the funnel and thinking about the waste that was going on. My watch below did not begin for one hour later. While soliloquizing in this way, along came the head fireman on my watch, and I said to him:

"B——, I will give you a dollar and the other two on your watch one dollar each if we run to a certain point and no smoke shows at the funnel."

His reply to this was:

"I will do it."

I posted two or three of the watch on deck to note conditions, and from time to time came on deck to look for myself. There was at times the slightest trace of smoke. I do not mean to say that it was entirely eliminated, but it was simply a trace.

They won, and so did I, for they convinced me then and there that there is a way, and only one way, to fire—that is, fire often and light, which I compelled them to do. Keep a thin live fire, not a great thick one which is only alive on top. Firemen like to fill up the furnace—and likewise their pipes.

Now of what use in seeking refinements of design when no attention is paid to the fire room? Is it fair to argue on the relative merits of different types of prime movers when no attention is paid to the source of power? It is up to the seagoing engineer to show economy after it has been proved by the designing engineers that certain results can be obtained, and it would pay many designing engineers to listen to the sea-going engineers and work together to get the best from actual experience. I again reiterate that greater economy can be obtained if the engineer on watch compelled his firemen to fire properly.

The evaporation of water and the pounds evaporated is quoted by some as a criterion of the firemen's efficiency, and it is, they say, very high. Yes, it is high, and the water disappears, but go into the engine room and see it streaming down the valve stems and piston rods. A calorimeter is an unknown quantity, so is the dryness factor of the steam. Separators on main steam lines are frequently conspicuous by their absence, and this condition is permitted to exist.

The above illustration of the ability of firemen to produce results resulted in this case in an enormous saving in fuel, and they had sold themselves for one dollar. Let us have more intelligence in the fire room, and perhaps we can show even greater economy for any prime mover. Let the designing engineer introduce refinements in design, not go plodding along in the same old rut. I admit that they are to a certain extent forced to do certain things to cheapen construction, and the object of the builders is to build and get the product off their hands; but I contend there is far greater economy in the reciprocating engine than now obtains on many of our ships, partly in design, and partly to handling in every-day practice, and it is in great part up to the operating engineers to get it out of them. Why is it that when running a test the performance of a ship is higher in many cases than when in every-day running? I have found it to be due to an intelligent method of firing. I could enumerate many cases and submit data proving this, but it would only prove what has been said. I do not purpose going into an argument as to the relative merits of turbine over reciprocating engines, because it is not necessary, but in any case the performance of both can be improved, and that by the engineers in charge of the plant.

Charles S. Linch.

Explosion of a Watertube Boiler.

Editor International Marine Engineering:

The explosion I am about to write of took place on board a side-wheel steamer. The boiler was of the Haythorne watertube type. It has 270 tubes arranged in nine sections or elements, each section containing fifteen tubes in height and two in width; the length of the tubes varying from 9 feet 1 inch in the bottom rows to 14 feet 3 inches in the top or outer rows. The tubes forming the bottom, middle and outer rows are 3⅛ inch in diameter, reduced to 2 inches in diameter at either end, and varying in thickness, according to their position, from .212 inch to .160 inch, the row next the fire being the thickest. The remaining tubes are 2 inches in diameter, and vary according to their position from .160 inch to .128 inch in thickness.

The whole of the tubes are of solid drawn steel, manufactured by the Mannesmann process, and are connected to the headers by means of brass ferrules screwed twelve threads per inch on the outside and sixteen threads per inch on the inside. The headers are made of malleable cast iron, each front one having a diaphragm at its upper end, so as to allow of the back rows of tubes acting as down-comers, while the remainder act as up-comers. A brass saddle casting, having a central division throughout its length to suit the up-and-down-comer arrangement, is riveted to the bottom of the steam drum, and each of the front headers is attached to this casting by means of four 1-inch bolts.

A screwed ferrule connecting one of the bottom tubes to the front header was forced out of its socket, which allowed the tube to come out of its place sufficiently far enough to permit of the contents of the boiler escaping between the end of the tube and the face of the header. The steam pressure in the boiler when this occurred being 200 pounds per square inch. This explosion resulted from the failure of the screwed threads of one of the ferrules by which the tubes are connected to the headers. The ferrules are screwed on the inside and outside with threads of different pitch, and although the arrangement no doubt allows the cone ends of the tubes to be forced very tightly into the headers, and unless the greatest care is taken in the operation, the strain on the threads is likely to be excessive and more than sufficient to cause them to be damaged. The use of the rubber washers I have referred to have not, so far as I am aware, the good opinion of many marine engineers. Exception has also been taken to the fineness of the screwed threads on the ferrules. The steam and water drum is 3 feet 6 inches diameter and 6 feet 3 inches in length. The dished ends are 1⅛ inches thick, stayed by means of four through stays, 2¾ inches diameter. The boiler is fitted with the usual mountings, the safety valve being loaded to 200 pounds per square inch.

Camden, N. J. F. J. S. N.

The annual report of the Secretary of the United States navy makes a recommendation to Congress for an allowance for commanders-in-chief of fleets for purposes of official entertainment. This recommendation is one that should receive most hearty support on the part of law makers, for the best way to keep up the friendliness of one navy with another is that of proper entertainment, and with the limited incomes that navy officers have, and especially the necessity of those who are married maintaining homes on shore as well as contributing to the mess on his own ship, makes a great drain upon their resources. It is only ordinary justice that it should be left to the discretion of the commander-in-chief to make proper use of an allowance that is at his disposal for this specific purpose.

A record in shiploading was made in Baltimore, Nov. 23, at the Curtis Bay coal pier of the Baltimore & Ohio Railroad. The collier *Newton*, owned by the Federal Coal & Coke Company, was loaded with 7,029 tons of cargo coal and 545 tons of bunker coal in 4 hours and 35 minutes.

Review of Marine Articles in the Engineering Press

Ships

Two New Allan Liners.—Orders have recently been placed with Messrs. William Beardmore & Company, Ltd., and the Fairfield Shipbuilding & Engineering Company, Ltd., for the building of two fast passenger and freight ships for the Canadian service. These new vessels will be the largest and fastest ships on this route. Although the speed expected is 20 knots, all has not been sacrificed in the design to power, for the passenger capacity is 200 first class, 500 second class and 3,000 third class, all in staterooms, besides 3,000 tons deadweight of cargo. Special attention is paid to passenger accommodations, with the result that unusual features for this service have been introduced. The vessel will be propelled by Parsons turbines, driving four shafts, with a total shaft-horsepower of 19,000. There will be six double-ended and four single-ended boilers, worked under Howden's forced draft system and arranged for burning oil or coal. Features of the hull design are Frahm anti-rolling tanks and a stern designed on the lines of a cruiser. This enables the steering gear to be placed beneath the waterline. The vessels are classed under the rules of the British Corporation for the Survey and Registry of Shipping. 800 words.—*Engineering,* November 3.

French Submarine Salvage Boat.—A craft of very unusual design intended for the salvage of wrecked submarines of the French navy. The hull is in two separate parts aft though joined forward and coming to the same stem. A strong bridge structure covers and joins the separate parts aft. The space between the two is large enough to contain the largest submersible built or building for the French navy. The vessel will carry electrically-operated lifting apparatus, but will not be self-propelling. As the form and size of the ship make its handling by tugs in high wind or rough weather a very questionable operation its performance is watched with much interest. The length over all is 328 feet and breadth 83 feet 11 inches, draft in light trim 4 feet 7 inches. Launched on September 22 by the "Ateliers et Chantiers de la Loire," of St. Nazaire. Article illustrated. 360 words.—*The Engineer,* November 3.

Turbine-Driven Steamer Newhaven.—The latest addition to the cross-channel fleet between Dieppe and Newhaven, the *Newhaven,* was built by the Société Anonyme des Forges et Chantiers de la Méditerranée at their Havre works. The principal dimensions are: Length over all, 302 feet; breadth, 34 feet 7 inches; depth, 22 feet 2 inches; draft, 9 feet 8 inches. The hull is divided into eight compartments by seven watertight bulkheads extending up to the main deck. Accommodations are provided for 1,000 passengers. Propelling machinery consists of Parsons turbines driving triple screws. The turbine rotors and shafting are of Siemens-Martin steel. Stern tubes and propeller shaft supports are steel castings, while the propellers are of Stone's bronze. The bearings are water-cooled. Steam is supplied by eight Belleville boilers, at a working pressure of 250 pounds per square inch. The total grate surface is 646 square feet, and total heating surface is 17,100 square feet. Forced draft of the closed stokehold system is used. Air is supplied by four fans driven by vertical engines.

There are two condensers, each having 4,220 square feet of cooling surface and connected to a centrifugal circulating pump of a capacity of 385,000 gallons per hour. Each condenser has separate air pump which can draw from either condenser. Full-speed trial gave a speed of 24 knots, at which there was no vibration except astern where the screws throw the water against the hull. At 12 knots, ship can be brought to a dead-stop in thirty seconds over a length of less than 300 feet. 1,100 words.—*Engineering,* November 10.

New Cross-Channel Steamers for the South Eastern & Chatham Railway.—The new turbine steamers *Riviera* and *Engadine,* built by the William Denny & Bros., of Dumbarton, for the cross-Channel service, are very much like the vessels already on these routes, except that they are a little larger, being 315 feet in length, 41 feet molded breadth, and 24 feet 6 inches in depth from the awning deck. The ships are driven by Parson turbines turning triple screws, and steam is supplied by six Babcock & Wilcox boilers, with a seventh in reserve, to provide for one being always off duty for cleaning. On trial the *Riviera* maintained a speed of 21.99 knots for four hours on four boilers, and made a highest mean speed for one hour of 23.07 knots. The passenger accommodations of the vessels are quite similar to other vessels of this class. 600 words.—*The Engineer,* November 17.

The World's Largest Bulk Freighter.—There was recently completed at the Ecorse yard of the Great Lakes Engineering Company the bulk freighter *Col. James M. Schoonmaker,* of the Shenango Steamship Company's fleet. Its dimensions are: Length over all, 617 feet; beam, 64 feet, and depth, 34. This is 6 feet more beam than is usual for the 600-foot type of lake freighter, but as the vessel handles very easy the change is considered a success. The hull is of the arch girder construction, the hold being divided into three compartments. The hoppers at the sides form sloping sides for the cargo unloaders, easy working, and water ballast tanks, in addition to those in the double bottom, giving a total capacity for water ballast of 8,000 tons. There are 35 hatches, 54 feet wide and 9 feet fore and aft. The maiden cargo of 10,799 tons of ore was unloaded in 5 hours and 9 minutes net time. There are accommodations for a limited number of passengers, and special attention has been given to providing everything for their comfort that could be devised. The latest designs in cabin furnishings and furniture were installed and particular pains taken with the sanitary system. Every stateroom has its private bath and shower with the best of plumbing and fixtures. The propelling machinery consists of one quadruple-expansion engine, with cylinders 23, 33¼, 48 and 69 inches by 42 inches stroke. Steam is furnished at 220 pounds working pressure by three Scotch boilers, 14 feet 9 inches diameter by 12 feet 2 inches long, each containing three 44-inch furnaces. The arrangement of the cylinders places the high-pressure forward, the low coming next, the second intermediate and the first intermediate in the order named. The high and intermediate cylinders are fitted with piston valves, the low with a triple-ported slide valve. All are operated by Stevenson link gears, but the second intermediate and low gears being operated by a single rocker arm. Air pump is worked from low-pressure cross-head. Metallic packing is used throughout. A very complete set of auxiliaries are installed, doing all work and furnishing all the service that could possibly be done by machinery. The article is well illustrated by numerous photographs. 3,300 words.—*The Marine Review,* November.

Naval Architecture

The Residuary Resistance of Vessels.—By Ernest Saxton White, B. S. Read before the North East Coast Institution of Engineers and Shipbuilders. An investigation into the resistance of vessels caused by wave making and eddy taken from a large number of trials and analyzed with the purpose of obtaining an exponent for the term V (speed) in a formula

whereby residuary resistance might be calculated. Although founded on no scientific basis, the results are very interesting and particularly constant. Laying aside the computation of the resistance due to skin friction, which is obtained in the usual well-known manner, the author proposes three factors which govern the residuary resistance: 1. Relation of beam to draft. 2. 'Midship section area coefficient. 3. The form of the ends, the product of which he makes equal K. The value of the third factor is the end coefficient multiplied by the number of beams in the length. If V is speed in knots, x the exponent of this speed, then this coefficient K times V^x equals the residuary power necessary to overcome the residuary resistance. From the analysis of trials made this x is found to equal 2.7 with surprising regularity. No claim is made that this should be so invariably, but the author suggests that designers try the method with the data at hand and check both the method and the value of the exponent. 1,500 words. —*Engineering,* November 3.

The Development of the Holland Submarine Boat.—A lengthy illustrated article containing a complete review of the Holland submarine boat from the first boat built, the *Holland,* to the latest special type design of the present time, followed by special consideration of such topics as provisions for safety, submergence tests and strength, diving mechanism, interior arrangements and stability conditions. The improvement in submarines within the last twelve years may be known from a comparison of the *Holland,* built in 1898, and the latest type now under construction and completed. The former was about 70 tons displacement submerged, with a surface speed of 6 knots and submerged speed of 5 knots. Although exact data of the latest vessels are not given, it is said that they will be between 400 and 500 tons displacement when submerged, with a surface speed of 14 knots and a speed submerged of about 11 knots. They are twin-screw vessels with heavy oil engines and have four bow-torpedo tubes. Vessels of the latest type completed are considered structurally strong enough to withstand pressure at a depth of 250 feet, and are actually tested to a depth of 200 feet. This test is made without a crew, and is regarded as a final precaution against hidden weakness. Holland submarines dive at an angle of not over 2½ degrees except in emergencies. Their hull design is such that the metacentric height increases when the vessel is submerged. This insures sufficient stability for safety in all submerged operations. The article is well illustrated with photographs of vessel diving and interior views and diagrams of stability conditions. 8,500 words.—*Engineering,* November 17.

MARINE ENGINEERING

Crude Oil Marine Engines.—By James H. Rosenthal. Read at British Association for the Advancement of Science, at Portsmouth. A lengthy article giving in descriptions, figures and numerous illustrations the actual state of development of oil engines used for marine work. The author first discusses the general problem of the oil engine designed for large powers, which he stated to be the creation of engines of large power to work as simply on cheap crude oil as the present small motors work on high-priced oils. The great desirability for this is not the saving in fuel cost, for this is small, but in the saving of space, crew's wages and convenience in fuel handling and storage. Follows then a description of the Bolinder engine, which has been fitted to some extent on fishing vessels and barges. The engine does not work on the Diesel principle, but has a heating chamber, which is the source of the ignition. These engines are not hard to operate, and are easily within the ability of some member of a fishing crew. The rest of the paper deals with larger engines operated on the Diesel cycle, both single-acting and double-acting, and describes in some detail the types that have been built and the boats on which they were installed. First used for submarines they were later used in a variety of types; for the propelling power of navy pinnaces they have gone to Argentine, and have also been used as auxiliary power on a large French sailing ship. The reversible double-acting engine is about to be tried on a commercial scale by the Hamburg-American Line in a vessel now being built by Messrs. Blohm-Voss. Toward the last the author describes the mechanical details of both single and double-acting types of the Nurnberg or Diesel cycle engine. 6,600 words.—*The Marine Review,* November.

The Efficiency of the Gas Turbine.—An editorial consideration of this important question, in particular reference to the article reveiewed above. The author calls attention to the fact that no definite statement is made by Mr. Holzwarth as to actual fuel consumption per kilowatt-hour, which he says is an omission, from which our readers will draw their own conclusions. There are given diagrams of efficiency curves, but their precise meaning is a matter of doubt. If it may be correctly inferred that this efficiency is the over-all efficiency from area of indicator diagram to actual output of work the figure is only a fraction of what may be expected from a good reciprocating gas engine. Mr. Holzwarth claims for his turbine an efficiency of 58 percent; from this the over-all efficiency referred to above works out 11.2 percent. With good gas engines values as high as 36 percent have been registered. In experiments in France results more discouraging have been obtained. In an attempt to use turbines to drive torpedoes, where the compressor difficulty does not exist, since either engine or turbine has to have a supply of compressed air, the results of repeated trial were decidedly inferior to that obtained by the present reciprocating engines. 1,600 words.—*Engineering,* November 24.

The Marine Speed-Reduction Gear as a Commercial Proposition.—Heretofore the speed-reduction gear has been considered primarily from an engineering standpoint and investigated largely with the view of whether or not it would work. This article is an editorial consideration of the objections to the various devices which have been introduced from the business point of view. In doing this the author has taken three types of ships for discussion—the fast passenger liner, the intermediate and tramp steamer and the warship. As an example of the first the *Mauretania* is chosen. Any saving of space or power due to the use of a reduction gear might be used to increase speed, decrease fuel consumption, increase radius of action, or increase carrying capacity of the ship. In this case, any increase of speed due to a small increment of power would be scarcely appreciable; the vessel is designed for a certain run, hence radius of action need not be increased; she is a passenger ship, and already has accommodation for the small amount of freight carried; the space saved is in the boiler and engine rooms, and hence not available for passengers. The only direction left that would be benefited would be in the saving of fuel, and this the author shows would be a small percentage, about one-half of 1 percent of the passenger receipts alone. As for the intermediate type and tramp the application here is limited, because the reciprocating engine still holds sway. In future there is a possibility that a small saving in fuel may tempt builders and owners to make the change. In warships the problem is not of so great importance economically. There the question is one largely of expediency and simplicity of design. As it is now with reduction gears there are many unsolved questions which increase the uncertainties to be considered. 3,300 words. —*The Engineer,* November 17.

The Junkers Marine Oil Engine.—Engines of this type are being installed in a new freighter for the Hamburg-American Line building at the works of the Weser Company, of Bremen.

Besides being one of the earliest planned installations of oil engines of any size for marine work it is of unusual design. The engine burns heavy oil fuel in much the manner of a Diesel engine. Each cylinder, however, contains two pistons working in opposite directions, and connected to cranks on the same shaft at 180 degrees with reference to each other. Each cylinder works on the two-cycle principle, but by arranging them in tandem double action is obtained. Since the pistons themselves open and close the cylinder ports, valve gear and scavenging valves are done away with, as well as cylinder covers and stuffing-boxes. Satisfactory tests were run on an experimental engine of 200 horsepower, built by Professor Junkers, from which the data for the present engines were obtained. Later a 1,000-horsepower horizontal stationary engine was built. The article is well illustrated by plates and diagrams of the cycle, description of which is too complicated for satisfactory treatment in a review of this length. 1,200 words.—*Engineering,* November 24.

The Gas Turbine.—By H. Holzwarth. An abbreviated translation of a paper read in German before a meeting of the Schiffbautechnische Gesellschaft held in Berlin November 23 to 25. A brief and none too satisfactory account of a gas turbine built for the author by the Messrs. Korting, A.-G., Hanover. The machine consists essentially of a number of explosion chambers in which charges of air and gas unite, and are exploded at proper intervals, over which is suspended on a vertical shaft a turbine wheel and above it a generator. The whole is enclosed in a casing, which holds the valves opening into the explosion chambers and supports the shaft bearings, governor gear and scavenging apparatus. Inlet valves allow the air and gas to enter the chamber one after the other. Upon being ignited the greatly increased pressure causes a nozzle valve to open, and the available energy in the gas is transformed into kinetic energy, which is transformed into work by passing through and acting upon the turbine wheel. Low initial pressure is used, and this is augmented by a vacuum in the exhaust. The turbine works usually with suction producer gas of 1,100 to 1,200 calories per cubic meter, and has been designed for 1,000 horsepower at 3,000 revolutions per minute. Smooth running has been obtained at all speeds, although a temperature of 500 degrees C. was reached in the turbine casing. Complete scavenging is necessary to prevent it going even higher. It is claimed that the area of this engine's floor space is to that of usual gas-reciprocating engines as 1 is to 3.28; the total weight as 1 is to 4.2. The gas turbine, like the steam turbine, works without shock and vibration and saves the expense of cylinder lubrication. Lubrication of moving parts is thorough and reliable, since all movable parts are in oil baths. With the article is a drawing of the turbine, and diagrams showing efficiency curves for different charges and the normal indicator diagrams for the explosion chambers. 1,700 words.—*Engineering,* November 24.

MISCELLANEOUS

Johnson's Direct-Reading Torsion Meter.—The co-inventor of the well-known Denny & Johnson torsion meter has carried his investigations farther in the same direction, resulting in a direct reading torsion meter whereby one observer can read simultaneously the torsion in one or more shafts by merely glancing at as many dials. The new device is made exclusively by Messrs. Kelvin & James White, Ltd., of Glasgow, and is arranged so that the torsion in the shaft is proportional directly to the resistance of a current passing through a contact piece of high resistance, the same being measured by a voltmeter, which reads directly in terms of torque. From this the usual method is used for obtaining shaft-horsepower. The advantages of this instrument are its adaptability to stationary as well as marine engine shafts, its freedom from error arising from distortion of hulls, as frequently occurs in destroyers and other light high-powered vessels, and in the great advantage of placing the indicating board in any part of the vessel. The article is well illustrated by photographs and drawings. 1,600 words.—*Engineering,* November 3.

Submarines and War Tactics.—An editorial commenting upon the effect of a fleet of submarines in the Turco-Italian war, if used to good advantage, shows how the development of the submarine has raised it from use as a moral effect to a serious factor as an effective fighting unit; reviews the tactical value of the vessels of the present day, and states the strength of the first naval powers in this branch of the service, together with the national policies of each. The editors consider that owing to an agreement with the builders whereby the British government placed all orders with the same firm, and this company gave the government exclusive benefit of all experiments and experience in developing the type, that they have at present the most efficient type of submarine yet brought out. 1,500 words.—*Engineering,* November 17.

The Thermo-Feed Automatic Water Regulator.—A device to keep water level in boilers very nearly constant. Consists of a float in a chamber open to steam space and water space of the boiler, and so adjusted that when water level is higher than that wanted float closes a spring-pressed feed check, which is normally open. The difference between this and the usual type being that it operates directly from the boiler and not from filter box, as is often the case. 750 words and sketch.—*The Marine Engineer and Naval Architect,* October.

The Steam Engine Indicator.—Its History and Application. Prize Essay of the Institute of Marine Engineers, by J. D. Boyle. An account of the development of this important instrument from the days of James Watt to the present, and a description of the best-known makes in use now. Shows how the changes in engine design called for improvements in indicators and how they were met. 2,500 words.—*The Marine Engineer and Naval Architect,* October.

Acetylene Welding and Cutting Machine.—Describes the Davis-Bournonville type of apparatus and describes method of using machine to weld sheet metals together and as used in cutting metals by melting the plates on the line of separation. This is accomplished by means of an oxygen-acetylene gas flame of 6,000 degrees F. temperature, which is run along the line at a speed of about a foot a minute. Preheating the metal to be cut by less expensive flames have been tried and found to be an improvement; 1,200 words.—*The Marine Review,* September.

Canal Traffic Motor Barge.—An experimental craft built by a London company to test the feasibility of developing traffic between London and the provincial towns. Of 71 feet 6 inches length, 7 feet beam and 3 feet 6 inches draft with 30 tons load. The barge can tow another, similarly loaded, and can pass through practically all the canals of England. The engine is a 10-horsepower Brooke kerosene (paraffin) motor, which works on the Otto principle. The reversing gear is a simple clutch. Oil pump is worked off a cam. 700 words and photographs of engine, clutch and loaded barge.—*The Marine Engineer and Naval Architect,* October.

The New York Shipbuilding Company, Camden, N. J., has installed a new type of crane at its plant. This machine is of the revolving locomotive type, mounted on a gantry. While machines similar to this have frequently been used, especially at the plant of the Maryland Steel Company, this machine is novel, in that it is arranged to travel backward and forward on a gantry so as to serve two sides of the pier. It is also of quite a large capacity.

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Notwithstanding the growing popularity of the Diesel engine for propelling machinery in the maritime world, few have realized the extent to which it has been used in Russia or the large installations which have been made there. Some interesting data in this respect are given in our leading article this month in which there is a résumé of the actual installations which have been made in Russian vessels since 1903. One of the remarkable features of the Russian Diesel-engined craft is the use of horizontal engines driving side paddle wheels through gearing, boats of this type being used as tug boats for river service. That the Diesel engine should be used to a greater extent in Russian vessels than in those of the other continental countries is not surprising, on account of the extensive supply of petroleum in Russia. With a sufficient supply of heavy oil suitable for fuel in a Diesel engine, and available at a moderate cost, the inherent advantages of this type of engine become more important from a commercial point of view. Since the United States produces a higher percentage of the world's supply of petroleum than does Russia, it might be expected that a similar progress in the adoption of heavy-oil engines would take place in America as in Russia. Heretofore the difficulties with American-built heavy-oil engines seem to have been largely of a mechanical nature. That this should be speedily overcome with the growing demand for this type of engine is to be expected, and, in fact, is already apparent.

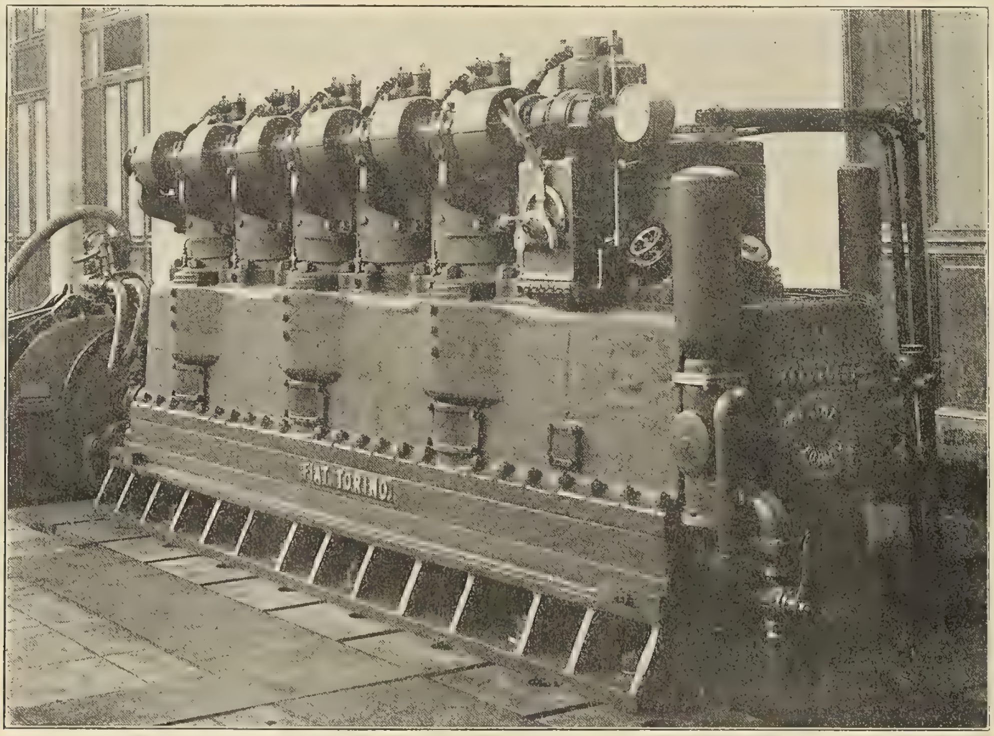
Economy in the fire-room is sometimes taken for granted by the owners and builders of steam vessels, and if a ship of excellent design is brought into service it is expected that as a matter of course it will show the best over-all economy that could be obtained. As a matter of fact, however, such a vessel, even if it has the minute refinements in the design of the power plant which are necessary for maximum efficiency, may lose the benefits of these refinements by the inefficient work of the engineers in operating the ship. Some of the most common examples of this kind are pointed out very forcibly in one of the letters from practical marine engineers in this issue, wherein are shown the different results which may be obtained by the men in the stokehold. A matter of first importance here is to obtain complete combustion of the fuel, some indication of which is given by the amount of smoke emitted from the funnels. Further than this, the steam generated should be dry or a discouraging amount of the water may disappear from the boilers and go through the engines without doing any work. Such points as these might be called the most elementary part of marine engineering, but still they are fundamental, and should be given first consideration in every case.

In almost every seaport it is impossible to have direct connection between the various rail and water transportation terminals, and some link is required to provide for the transference of freight from rail to water and vice versa. This condition has resulted in an enormous growth of means for transferring freight from the railroad terminals to the steamship piers by water. This is of particular importance in New York harbor on account of the natural conditions of the harbor which affect the location of both the railroad and steamship terminals. As shown in the article on lighterage, published in this issue, three-quarters of the harbor freight in New York is moved by lighters, and this method of transference is more economical than by drays or transportation on shore; but on account of the great volume of freight movement by lighterage and the lack of mechanical appliances for moving the freight from the deck of the lighter to the hatch of the steamship, a great deal of costly congestion occurs about the slips and piers. Such a condition offers a problem which should be readily solved by scientific investigation and the application of improved appliances for the rapid handling of freight.

Improved Engineering Specialties for the Marine Field

Fiat Heavy Oil Engines

The Fiat Company, Turin, Italy, well known all over the world for their motor cars and gasoline (petrol) engines, have recently taken up the construction of internal-combustion engines, using heavy oil as fuel. The first of these engines built were of the lightweight, quick-running type, specially designed for use on submarines, torpedo boats and on auxiliary boats for large battleships. The success of this type of motor is evident from its use in the Italian navy and by many foreign Admiralties, one well-known instance of which was the installation of the gasolene (petrol) engines on the Swedish submarine *Hvalen,* which accomplished a record voyage from Spezia to Stockholm. After having obtained satisfactory results with the light and high-speed type of heavy oil engines for marine use, and having solved the problems relating to reversing and control, it was a natural step for this company to undertake the construction of higher powered engines, but not with the former limits of weight and space. The Fiat Company is now building heavy oil engines for installations of several thousand horsepower, both on board ship and for stationary work. These engines are all of the two-stroke cycle type, with combustion at constant pressure, and the normal types are built in two series—the Standard industrial type for stationary work and for merchant marine installations, and the high-speed type for naval work or for special applications. The number of revolutions in the first series varies from 150 in the 1,000-horsepower engine up to 3,000 in the 100-horsepower engine. The weight of the engine with accessories is about 88 to 110 pounds per horsepower. The number of revolutions of the high-speed type varies from 450 in the 1,000-horsepower engine to 600 in the 100-horsepower engine. The weight in this case is about 35 to 44 pounds per horsepower. In addition to these normal types the Fiat Company is also building special types designed for exceptional purposes. Just at present the question of using this motive power for the propulsion of large warships is being given much attention by the Fiat Company.



TWO-STROKE CYCLE, SINGLE-ACTING, SIX-CYLINDER, 600-HORSEPOWER FIAT HEAVY OIL ENGINE

The illustration shows a 600-horsepower engine which runs at 500 revolutions per minute. It is of the normal two-stroke cycle, single-acting type with six cylinders. The lower part of the motor consists of a base plate, which carries the main bearings of the crankshaft. On this plate there is a frame to which are secured the working cylinders, which are cast separately. There are no independent pumps for the supply of the scavenging air necessary for the two-stroke cycle engine. This is furnished by pistons in the main cylinders, there being pistons of double diameters where the upper part, which has the smaller diameter, is the working piston and the lower part acts as an air pump. This arrangement, it is claimed, reduces considerably the length of the engine and enables it to be balanced more easily. The upper part of the frame is used as a reservoir for the scavenging air, which is compressed to from 3 to 6 pounds per square inch, according to the number of revolutions. The air is led through conduits cast in the frame and cylinders to scavenging air valves, which are placed two on each cylinder top, together with the fuel valve and with a compressed air admission valve for starting purposes. The exhaust in the two-stroke engines is accomplished through ports in the wall of the working cylinder, which are uncovered by the piston at the end of the downstroke.

At the forward end of the engine, and operated by an extension from the main crankshaft, is fitted a two-stage compressor for supplying highly compressed air for starting purposes and also for the fuel injection. Near the compressor at the end of the engine, and actuated by the main cranckshaft with a speed reduction gear, there is a group of pumps, consisting of a pump for the cooling water for the cylinders and main bearings, and a pump for the lubricating oil. This oil is also used for cooling the tops of the working pistons, as

the cooling obtained by water in types of engines of such a reduced size brings out some serious defects.

The scavenging air valves, the fuel valves and the fuel pump are operated by a horizontal shaft placed in front of the motor, which is itself actuated from the main crankshaft by means of a secondary intermediate vertical shaft and two pairs of worm wheels. On the horizontal cam shaft there is keyed a separate eccentric for each cylinder, which operates the scavenging air valves and the fuel valve. The motion for each cylinder is operated by means of a single angular cam, which receives from the eccentric an oscillating motion, and in one of the end positions opens both of the scavenging air valves and on the other end lifts the fuel valve. In the diagram of the normal distribution on these engines the middle point of the fuel injection phase and the middle point of the scavenging phase are 180 degrees apart from each other, consequently in order to pass from the distribution corresponding to the direction of rotation to the distribution required in the opposite direction, it is sufficient to change the relative positions of the working eccentrics regarding the main crankshaft. This alteration is made by an axial displacement by compressed air of the vertical shaft of the worm-wheel which drives the horizontal distribution shaft. It is claimed that this system of reversing the engine is quick and easy, requiring neither complicated mechanical arrangements nor auxiliary shafts for cams, and, therefore, its operation is steady and reliable. One important advantage as compared to other systems is that the distribution for both the ahead and astern rotations is the same, and therefore the same torsion moment is obtained when the engine is running in either direction. It would also have the advantage that instantly after reversing the engine both the scavenging air and fuel valves are in the proper position.

Starting the engine, as has already been mentioned, is accomplished by highly compressed air admitted to each cylinder through separate valves. There are double profile cams on each cylinder, which are so keyed that they can slide on the horizontal distribution shaft, and their position can be axially displaced on this shaft by moving a small shaft which passes inside the hollow distribution shaft. When the cams are at either of the two end positions the starting valves are opened, and when the cams are in the middle position these valves remain closed.

It has already been stated that in each of the six cylinders there is a piston of a diameter larger than that of the working piston, which acts as a scavenging air pump. The suction and exhaust from these pumps is obtained by means of three piston valves, each valve serving two cylinders, whose cranks are at 180 degrees. These valves are moved by a horizontal shaft connected to the vertical shaft by means of a pair of worm wheels. The change in the relative position of the piston valves for reversing the engine is accomplished at the same time and in the same way as for the distribution.

Control for starting and reversing the engine and governing devices to regulate the speed is effected by means of a lever and handle, which is seen in the illustration in front of the control box placed at the end of the engine, corresponding with the vertical shaft between the last cylinder and the compressor. In the control box are the compressed air valves for the displacements and the fuel pump, with a device to regulate the supply of fuel to the cylinders. The upper lever controls the displacement of the worm wheels on the vertical shafts and the displacements of the cams working the starting valves on the horizontal shaft. The handle regulates the amount of fuel delivered from the fuel pump. With these arrangements control is very simple, and on some official trials made on a motor of this type for the Italian navy the reversing from full speed ahead to full speed astern has been carried out easily in five seconds.

The Diaphone

The diaphone is an instrument for the production of sound, which, it is claimed, is more economical and more powerful than the other types of instruments which have been used for this purpose. For marine signaling up to the present time sound has been produced by instruments of the bell type, steam whistles, sirens and reed instruments. It is a fundamental principle for instruments of this kind that a sound must be pure if the greatest benefit is to be obtained from the power expended, and that it can only be magnified or intensified by being in tune with the mouthpiece, trumpet or resonator, as the directing piece is usually called. The diaphone, as shown in the illustration, consists of a circular chamber, into which air or steam is admitted, and which is provided with circular slits through which the gas is allowed to escape in puffs, and

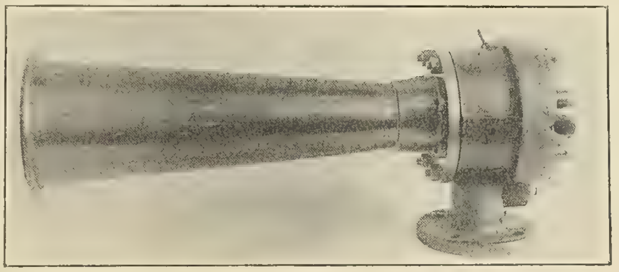


FIG. 1.—ASSEMBLED DIAPHONE

thereby producing sound. A piston, provided with a series of slits corresponding to the slits in the air chamber, moves to and fro very rapidly, opening and closing the slits, permitting the escape of gas at regular intervals. The piston is the only moving part of the instrument and it does not revolve. Its reciprocating motion is obtained by admitting air or steam under pressure from the circular chamber to both sides of the piston, which have different diameters. When pressure is applied to the side of the piston which has the smaller

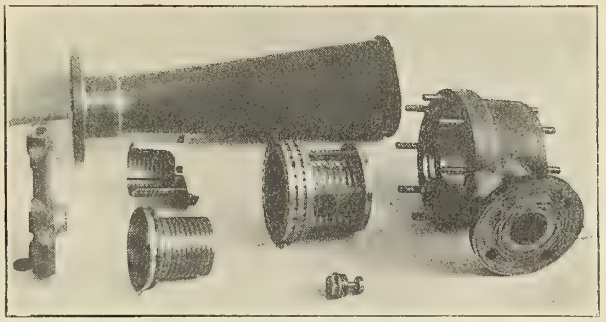


FIG. 2.—SEPARATE PARTS OF DIAPHONE

diameter, the ports are so located that the other side of the piston, which has the larger diameter, is exposed only to atmospheric pressure, therefore the piston is moved in that direction. During its movement ports are opened which admit the high-pressure air or gas to the side of the piston which has a larger diameter, and therefore the pressure on that side of the piston becomes greater than on the smaller side, due to the difference in their areas. This excess pressure moves the piston back in the opposite direction, which opens the exhaust ports. This allows the pressure on the smaller side of the piston to again assert itself and the cycle of operation begins again. The motion of the piston is very rapid, but, due to the location of the ports, sufficient space is left in the chambers to form cushions, which take up the shock from the moving piston and also limit the stroke of the piston. The instrument

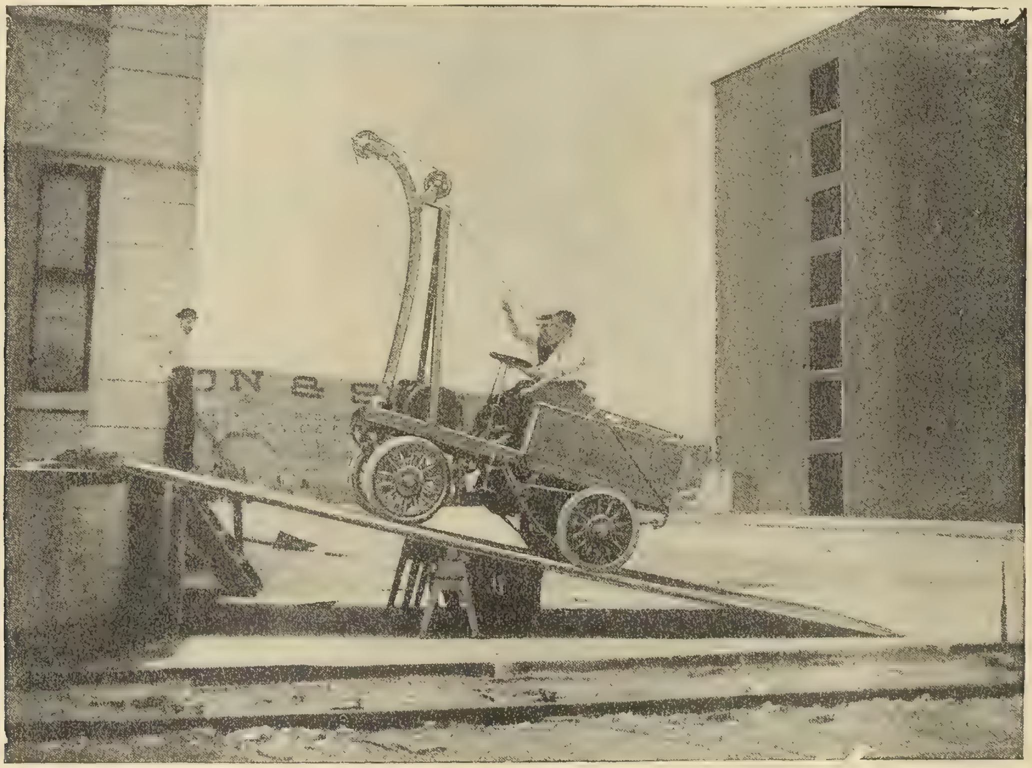
is self-governing; the piston, which is the only moving part, is very light and takes little power for its movement, and is designed as closely as possible to give a certain note at a certain pressure. The cylinder is made of hard gunmetal, and the piston of a much softer metal; therefore the wear occurs on the piston itself, which can be easily renewed at small expense and thus insure durability for the instrument. The manufacturers are the United States Marine Signal Company, New York.

Battery Truck Crane

A device for handling, with expedition and at a low cost, freight and materials, loose or in packages, which have to be lifted and moved through moderate distances, has been urgently needed, not only at the great railway and marine terminals, but also in manufacturing plants and many other places. To meet this demand the General Electric Company, Schenectady, N. Y., is now placing on the market the Battery Truck Crane, an electric vehicle which has a swinging crane mounted on the front end. The crane's hook is raised and lowered by a 1-ton hoist mounted on the front end just back of the crane, the motors driving the hoist and the vehicle being operated from a battery mounted on the rear end. The time, money and step-saving applications of this crane may be classed under three heads—hoisting, hoisting and carrying on the hook, and towing trailers, yet a given movement of material may involve one, two or all of these.

In case where material which may be sub-divided into parcels of 1 ton or less has to be deposited within a 6-foot or 8-foot radius, and this action does not require that the parcel be moved through a vertical distance of over 10 feet, the machine is brought into an advantageous position, the brakes are set, and the vehicle remains stationary as the boom of the crane moves back and forth between the picking up and depositing points. When material, in small or large quantities, has to be moved less than 400 feet, or in small quantities, to any distance, the article is lifted by the hook, conveyed to its destination by the vehicle, and placed on the floor on a rack or a high pile, as desired. For the miscellaneous transfer of large quantities of package freight or other material through a distance over about 400 feet, the best procedure is to use the Battery Truck Crane to tow trailers in trains of about four.

The Battery Truck Crane is designed for a high draw-bar pull, its maximum being a pull of 2,000 pounds, and equal to that of a 5-ton locomotive on rails and sufficient to spot a car, pull wagons or automobiles out of mud holes, and to readily handle loads of from 5 to 8 tons on trailers.



BATTERY TRUCK CRANE OPERATING UP AN INCLINE

A Condenser Tube for Marine Work

In marine work there has always been a need for a condenser tube that has a reasonably high coefficient of heat transfer and could successfully withstand the corrosive action of the salt water used for cooling purposes. Therefore the tests made on a Monel metal condenser tube by Mr. George A. Orrok, and presented in his paper on the "Transmission of Heat in Surface Condensation," read before the American Society of Mechanical Engineers, are of considerable interest, as the Monel metal tube showed a coefficient of heat transfer of .75 in comparison to copper's 1.00; but it is claimed that the great advantage of the Monel metal tube is that it is less corrodible than bronze, as strong as steel, and the finish is similar to pure nickel. Brass condenser tubes for protection are often tinned on the inside or both sides. Not only does this lower the coefficient of heat transfer, but, also, bimetallic tubes are apt to split. The Monel metal tube is made in one piece, thus eliminating this drawback. It is a fact that corrosion, oxidation, vulcanizing, pitting, etc., reduce remarkably the heat transferred, therefore a tube of Monel metal will stand up to its work and will not have to be often replaced, as is the case with tubes that cannot withstand the corrosive effect of salt water.

Monel metal tubes consist of 67 percent nickel, 27 percent copper, and 6 percent of other materials, so that the tubes are strong but ductile.

Combined Horizontal Punch, Beam Bender and Bulb Shearing Machine

The machine, which is designed for beam-shed work in a shipyard, consists of a twin horizontal punch at one end and a combined beam bending and bulb shearing machine at the opposite end. The punching apparatus consists of a strong slide working in accurately planed guides, carrying two punches side by side with special stop motion, so arranged that either one punch can be used independently but not both together, and also arranged so that in the mid position neither punch is operative. The capacity is to punch one hole 1¼ inches diameter through mild steel plate 1 inch thick. The depth of the gap is 18 inches. The dies are carried upon a readily detachable cast steel die head of special design, to enable holes to be punched in the root or flange of beams, etc.

A USEFUL SHIPYARD TOOL

A spare die head is also provided for punching holes in beams, etc., less than 6 inches deep. Efficient means are provided for the punching burrs to get clear away behind the machine. An adjustable roller is provided on each side of the gap to rest the work upon while passing through the machine.

The method of using this apparatus is to fix two punches of different diameters, say ⅝ inch diameter and 1¼ inches diameter. The ⅝-inch punch is used for rivet holes, which are punched consecutively until the point is reached where the larger hole is required, when the 1¼-inch punch is immediately available, after which ⅝-inch diameter holes are again punched consecutively until another large hole is reached. This avoids handling the bar or changing the punch.

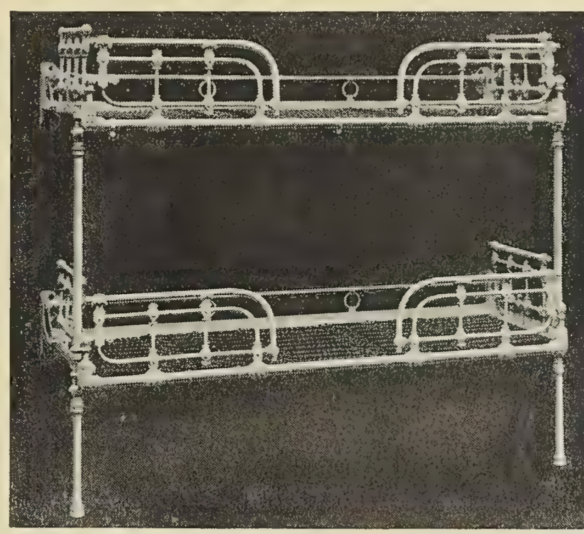
At the opposite end the bulb shearing apparatus consists of a strong horizontal slide of special design in cast steel, fitted with a shear blade capable of taking off the bulb from a beam or angle for a length of 6 inches at one cut, level with the web. It will also shear out a piece of the leg 6 inches wide at one cut. The slide is provided with independent stop motion by a convenient hand lever, and a spare slide is also provided for the smaller size of bulb angles, channels, Z-bars, etc. A convenient and efficient clamping device is provided to hold the bulb angle or beam in position while the bulb is being sheared off.

The beam-bending device is also at this end of the machine, and consists of one central cast steel hammer, which reciprocates continually with a stroke of about 2 inches, and two bending hammers, each sliding in planed guides and carried on the ends of strong steel screws, each provided with a large hand-wheel. These two hammers can be set at 4-foot 6-inch centers for beams, joists, etc., up to 15 inches deep, or at 2 foot 10-inch centers for lighter work. Adjustable rollers are provided at each side of the machine for passing the work through.

The body of the machine is a massive box-section casting, accurately machined where necessary and carrying the various slides in guides of ample area. The slides are actuated by a strong toggle from the main eccentric shaft. The main eccentric shaft is of Siemens forged steel running in long bearings, accurately machined, in the body of the machine and driven through powerful double-purchase cast steel gearing and heavy turned flywheel. The flywheel shaft is driven by machine-cut reducing gear by a continuous-running electric motor mounted on planed seatings on top of the machine. The flywheel shaft and second-motion shaft are carried in capped gunmetal-lined bearings in two strong gearing brackets, rigidly attached to the main body, with tongue and groove joints and pin-fitted bolts and rigidly stayed together. The whole machine is of massive rigid design, capable of doing the maximum work continuously at a speed of thirty strokes per minute at both ends. It is manufactured by Scriven & Company, of Leeds.

Ships' Berths

Whitfields Bedsteads, Ltd., Watery Lane, Bordesley, Birmingham, has been engaged for a good many years in the manufacture of high-grade ships' berths of all kinds, swinging,

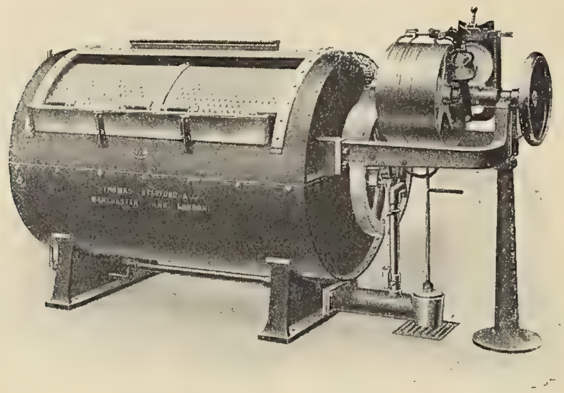


hanging, fixed, folding and steerage, with chain mattresses, woven wire mattresses or with galvanized lath bottoms. The illustration shows a folding-up berth, which is built with a special spring mesh, which is divided down the center from end to end, making it, it is claimed, impossible for the mattress to sag.

Bradford's Patent "Sugar" Washing, Boiling and Rinsing Machine

Thomas Bradford & Company, Manchester, have on the market a washing, boiling and rinsing machine in which the washing compartment is fixed eccentrically on its bearings and rises and falls with each revolution, thus forcing all of the washing suds or rinsing water through the clothes at each revolution. This feature, it is claimed, results in quicker and better work, with better economy of soap and water. Experiments have shown that the wear and tear and consequent depreciation of linen result from boiling and rinsing clothes at

the high speed necessary for the washing process, and so the machine illustrated has been developed, which, by a simple movement of a lever, reduces the speed during the rinsing



process. These machines have proved particularly useful in laundry installations on board large passenger steamships.

Arc Lights on the Ambrose Channel Lightship

Until recently it was considered impossible to use arc lamps on lightships and lighthouses, although their intrinsic brilliancy and color were considered very desirable for this work. One of the chief objections was that the weather conditions were too extreme. As a result of recent experiments, however, the lightship which marks the eastern entrance to the Ambrose Channel in New York harbor, and is officially known as the Ambrose Channel Lightship No. 87, has been equipped with this type of lights and has proved very successful.

The power equipment consists of two 7½-kilowatt marine type General Electric steam engine generator sets complete,

with panel boards and all necessary switches for controlling the circuit on the ship. There are two single masts, each carrying three lanterns of standard lighthouse design, which are hung in gimbals in order that the plane of illumination may be maintained horizontal regardless of a seaway. A vertical type carbon-flame arc lamp, operating at 110 volts, 6½ amperes, and giving a horizontal maximum candle-power of approximately 4,000, is placed in each lantern. The arc is placed at the focus of the lens, which is so located that the light emitted from the arc through a space of 60 degrees is concentrated and passes from the lens with a divergence of about 8 degrees, the result being that a powerful zone of light is projected in a horizontal direction. The three lenses are spaced at equal distances about the masts, and are so arranged that at least two of them are visible from any point of view. At a distance of approximately 2 miles the two lights merge into one apparent light source. In normal position the lamps are 55 feet above the waterline, and are visible for a radius of 8½ miles at sea level, 15 miles at an altitude of 15 feet, or 23 miles at 50 feet above sea level. The lights are first "picked up" by incoming vessels soon after passing Fire Island.

This equipment has now been in continuous service for more than a year, and such success has been achieved that steps are now being taken to equip other lightships in a similar manner, with the promise that the carbon-flame arc lamp will prove to be the most efficient illuminant for this most trying of all services.

Technical Publications

Warships and Their Story. By R. A. Fletcher. Size, 6 by 9 inches. Pages, 348. Illustrations, 80 full plates. Cassell & Company, Ltd., London. Price 21/-.

During the past twelve months quite a number of handsome illustrated volumes dealing with steam, sailing and warships have emanated from the press of British publishers. The volume before us is well up to the standard of the other popular volumes. The author recounts in non-technical and attractive style the development of the world's warships and follows the lines on which they have progressed. The subject is, of course, a tremendous one, and Mr. Fletcher seems to have been overwhelmed with material and acknowledges his indebtedness to a legion of authorities. No less than 80 full-page plates are included, and these are particularly well chosen and admirably executed. The colored frontispiece shows an impression of "A coming type of battleship" (an interpretation of the funnelless ship with internal-combustion engines, as suggested by Mr. J. McKenzie). A very carefully compiled index, which includes the names of all the ships mentioned, completes this interesting and attractive work.

Mechanical Inventions of To-day. By Thos. W. Corbin. Size, 7¾ by 5¼ inches. Pages, 323. Illustrations, 112. Seeley, Service & Company, Ltd., London. Price, 5/ net.

The series of popularly illustrated books on science of to-day has been added to by the above volume. The author issued a previous volume in the same series on engineering, which was exceptionally well received. We can foretell an equally good welcome for the new volume, which is most attractively got up. It gives in twenty-four chapters of non-technical language full and interesting descriptions of all the principal modern mechanical inventions. Some 112 illustrations and drawings are included; in many cases these are not working drawings but have been modified to enble the reader to understand the subject illustrated with a minimum of trouble.

Marine Steam Turbines. By Dr. G. Bauer and O. Lasche. Translated by M. G. S. Swallow. Size, 6 by 9¼ inches. Pages, 214. Illustrations, 103. London, 1911: Crosby, Lockwood & Son. Price, 10/6 net.

Dr. Bauer's work on the "Design and Construction of Marine Engines and Boilers" is well known to those interested in marine engineering, because it has long been recognized as a very complete and reliable treatise on the subject. The recent advance of the steam turbine for marine propulsion has been the occasion for the publication of a supplement to the volume on marine engines and boilers to deal in a like manner with the steam turbine. The need of such a supplement has been well filled by the book under review. A brief description of the theory of steam turbines is given to enable the reader to understand the calculations for steam turbines. Following the general remarks on the design of a

turbine installation and the calculation of steam turbines, the question of the design of a few of the common types of turbines is taken up, including the accessories. Shafting and propellers suitable for turbine installations and condensing plants are also considered. A part of the work which is of timely interest is that regarding the arrangement of different types of turbine installations on various kinds of vessels which is the result of actual practice up to date.

Communication

Naval Architects' Meeting

Editor International Marine Engineering:

To those who were fortunate to have been present at the last meeting of the Naval Architects and Marine Engineers' Society it would be a truism to say that the meeting was one of the most successful, if not the most successful one ever held.

The readers of International Marine Engineering will have seen in its pages some of the papers which were presented by the members of the society, and they can judge thereby to a certain extent the value of what was presented and discussed.

But one of the most important features was the fact of having Sir William Henry White at all the meetings, where his delightful personality interjected into the discussions something that cannot be conveyed by merely speaking of him. Let us drop for a moment the title of Sir William and we will find one of the most charming gentlemen, one of the most interesting talkers, and one of the most profound thinkers that can be met in the entire world. Certainly his title is well deserved, but were it even higher than it is it would not add one iota to his splendid character. He has every right to the title of a true man, and higher than this I do not believe a title exists. Everyone who met him is a better man and better informed by that meeting, and no better selection, in my opinion, could be found for the Fritz medal than he, and his beautiful speech of acceptance will be long remembered by all who heard it.

Certainly some of the papers suggested food for thought which cannot be digested in a moment. Mr. Harding adopted a most admirable plan of presenting a paper by means of lantern slides expatiating on the subject of the handling of goods at terminals in a way which added greatly to his paper It is a pity that a little more time cannot be given to subjects of such great importance, and it is a question in my mind whether it would not be wise to have a three days' meeting instead of two, as now. Mr. Harding fairly galloped through his interesting subject, which was a disadvantage.

Deputy Commissioner Barney's paper on the harbor of New York was something that brought up a matter of the very greatest importance; that is, the terminal facilities in New York City. It is absolutely beyond my own comprehension why it is proposed to make terminals on the Long Island side of the harbor. The very fact that it is an island is against the idea, and certainly the Jersey shore is the proper place for large terminals, as to the westward lies the main part of our country, and the one object of terminal facilities; that is, rapid handling of material after it reaches port, is far better obtained when directly shipped from the Jersey shore west than from any part of Long Island.

The whole question of handling freight more economically must be not decided *en bloc,* but must be settled by each particular locality and, of course, by the freight handled. Bulk cargoes, as pointed out by one speaker, can be handled on the Great Lakes in incredibly short time; but what we are concerned with in New York is the more economical handling of mixed freight.

Of course the turbine and internal-combustion engine question was to the fore, and it was regrettable that there was a little show of feeling in some of the discussions. It should be born in mind by every member of the society that all have a right to differ from the speaker, or concerning the paper, but that difference should be a mental and not a personal one.

Besides the papers read there was much discussion outside of the meeting between the members, and it was pleasing to note a very hopeful mental condition concerning American shipping. True, it was suggested by one member that it would be a pretty good idea to tear up some of our treaties, but the suggestion that the clauses in those treaties which work to a large extent against our merchant marine were interjected by the wise foreign nations who formulated them is hardly admissible, to my mind, as I believe they could be traced to their source nearer home; but it certainly is time for the people of the United States, who have appropriated to this the name of Americans, to find out whether the mere fact of commercial interests must stand in the way of a general betterment to the public. Mr. Nixon's suggestion as to special treaties with Mexico and countries to the south is certainly wise.

In the internal-combustion engine matter I am sorry that some of the statements were not questioned. One was that the up-keep of this style of prime mover is much less than that of the steam engine and boiler. I do not think that this can be shown to be a fact. One well-known vessel that made this port not long ago, heralded as the coming type of merchant-carrying vessel and fitted with internal-combustion engines, limped in, in pretty bad shape as to her motive power. Now to run an engine economically for an hour and then have it stop for several hours in order to make repairs, does not give an economical prime mover, and it is rather strange that in foreign countries the internal-combustion engine seems to be a far more satisfactory prime mover than it is in America. Not long ago I was asked where a well-known type of foreign internal-combustion engine could be built in the United States. These engines were large, none of them smaller than 400 horsepower. The gentleman who interviewed me stated that patterns would be furnished, and drawings and all material would be specified, and under no circumstances would any change whatever be permitted. He flatly told me that where he was operating, which was on this side of the Atlantic, he could not sell American-built gas engines, and the foreign-built engine had the market; but he thought he could save freight and money by having the engines duplicated in the United States, and I was somewhat chagrined to have him also say that the workmanship on the American internal-combustion engines was nowhere nearly as good as what was found in the foreign product, either English or Continental. My experience has not shown me that we are behind-hand in workmanship, but it has shown me the desire on the part of American manufacturers to alter things merely because American practice was somewhat different, and I know in several cases this change has been fatal to the successful operation of the mechanical contrivance.

The election of Mr. Cox to the secretary-treasurership was most satisfactory, but everyone regretted the necessary resignation of Captain Baxter. Mr. Cox's selection was admirable, not only in the man himself, but in the fact that it bridged over a little feeling that this position must be always held by a naval man. Mr. Cox having been a naval man and is now in commercial life breaks up this idea.

I would suggest that members of the society think carefully over the matter of three-day sessions, and as far as I am concerned I would strongly advocate it, as the delightful intercourse with members is now too short.

New London, Conn.

W. D. Forbes.

Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,001,668. SHIP'S-BELL CLOCK. WALTER K. MENNS, OF MALDEN, MASS., ASSIGNOR TO CHELSEA CLOCK COMPANY, OF BOSTON, MASS., A CORPORATION OF MASSACHUSETTS.

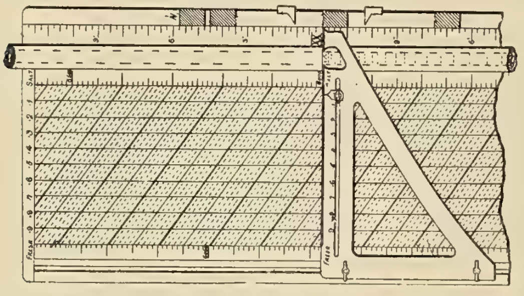
Claim 2.—The combination with a ship's bell clock having mechanism to actuate a single hammer at regular intervals double strokes with intervening rests, combined with means at alternate intervals to render one stroke of said hammer ineffectual, of a sounding device, and means operatively related to said actuating mechanism for controlling the operation of said sounding device. Ten claims.

1,001,601. BOAT. PAUL I. ANDREWS, OF KENNEBUNK, MAINE.

Claim 1.—A boat having a hull made from an integral piece of molded material with smooth sides whose upper edge is formed with an L-shaped off-set integral therewith, the base leg of said off-set extending horizontally inward and thence vertically upward. Four claims.

1,002,857. APPARATUS FOR INDICATING THE WEIGHT OF A VESSEL'S CARGO. DONALD MACKAY, OF ALLOA, SCOTLAND.

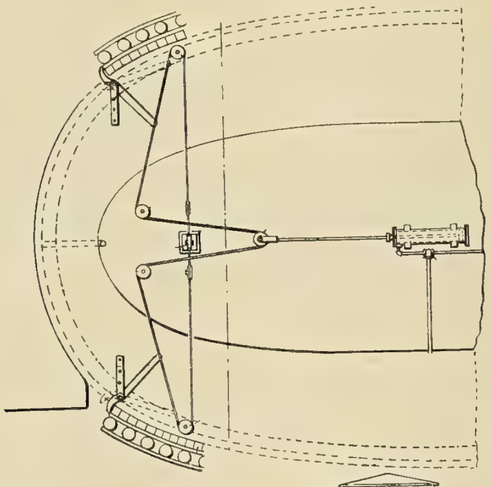
Claim 1.—In apparatus for indicating the weight of cargo in a ship, in combination. a water gage consisting of a tube open to the atmosphere and communicating with the water line below the "light" water



line of the ship, a scale of deadweight positioned in juxtaposition to said tube, said scale being provided with curves corresponding to the range of densities from fresh water to salt water and an indicator operatively associated with said scale and said tube adapted to indicate the deadweight corresponding to the density of the water and the height of the water in the tube. Two claims.

1,002,987. FERRY-MOORING DEVICE. GEORGE WALTER HARNEY, OF PORTSMOUTH, VA.

Claim 2.—A ferry boat provided with mooring hooks, a motor mechanism connected with the hooks for throwing the same outwardly to moor-



ing position, a pilot's controller for the motor, and means co-operating with the motor mechanism to retract the mooring hooks. Eleven claims.

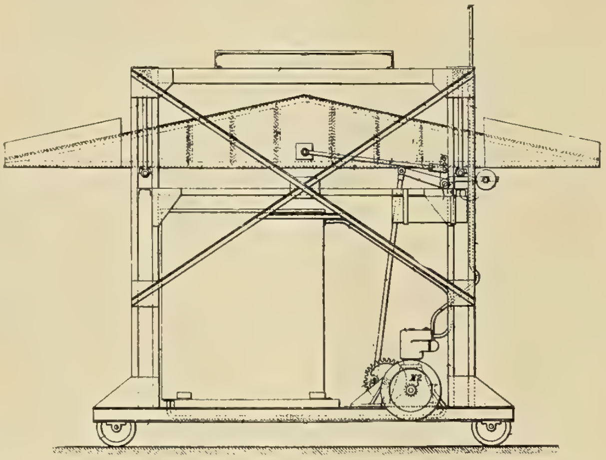
1,002,903. SOUND-RECEIVING DEVICE. SIDNEY M. DAVISON, OF CAMBRIDGE, MASS.

Claim 2.—In an apparatus for signaling under water, the combination of an inclosure secured to the skin of a vessel from which the air is adapted to be withdrawn; a casing contained within said inclosure and free from its walls adapted to contain a fluid; and a sound-receiving device within said casing submerged in said fluid. Four claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

3,480. RIDDLE TO ENABLE ORE TO BE DISCHARGED FROM SHIPS DIRECT TO RAILWAY WAGONS IN A RIDDLED CONDITION. J. DONALDSON, GLASGOW.

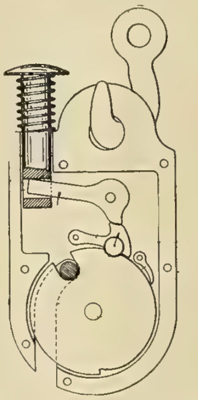
Certain ironmasters require ore delivered to them riddled to pass through a given mesh. Each tub of ore is taken from the ship to the quay, riddled and finally loaded into the wagons. In saving labor, time and expense by means of this invention, a riddle is provided of a con-



struction that will receive the ore without damage to itself, and made so that whilst it extends over the wagons, these may be readily moved independently of the riddle. A gantry runs on wheels, and beneath it trucks can pass. Above, a riddle is suspended by links, and is of a length and breadth such that it extends entirely over one truck, and its ends extend partly over the trucks on each side. The riddle is oscillated and a grating is secured above its center, and upon this the load first breaks its fall.

14,692. DISENGAGING GEAR FOR BOATS. J. W. WALKER, BRADFORD.

In order to ensure instantaneous and automatic release, this invention provides for obviating the friction common to these machines. The boat is secured to the tackle by a disc which holds the suspension ring or the



like in a notch. The disc is locked to its frame by a bowl carried by a lever and engaging a notch in the disc. A second lever locks the first until its longer arm is depressed by means of a push, a rope or the like; then the weight of the boat rotates the disc and so allows the suspension ring to leave the slot in the frame, the disc rotating no further, because the pawl engages notch. The boat is again locked in place by simply reinserting its ring into the slot, and so rotating the disc backward.

6,974. TELESCOPING TUBULAR MASTS. FONTANAMASTE-UND TRAGER GESELLSCHAFT, m. b. H., BERLIN.

The telescopic parts are in a casing, and are extended by a screw which is longer than each tube. Each tube has at its lower end a nut, and all of these, with the exception of the innermost, are out of engagement with the screw when the mast is retracted. On turning the screw, first the innermost tube is raised until it strikes with a projection against the top of the tube surrounding it. It then carries this tube with it so that the base of it engages the screw in turn and finally leaves screw, having been bolted to the tube by an automatic locking device.

28,639. HOLDERS FOR HOLDING OPEN CABIN DOORS, ETC. W. MULLAN, BELFAST.

A bar pivoted to the door frame engages an eye fixed to the door. The eye is open at the top, but does not permit the bar to pass upward until the eye has passed over it lengthwise to near the closed position. The bar is gapped at a point and can thus be lifted clear within the cabin. There is a cylinder containing a spring bolt for preventing rattle and for holding the bar vertically when not in use. A gap in the outer end of the bar allows it to engage the door against movement, and the eye and peg serve a similar purpose.

International Marine Engineering

FEBRUARY, 1912

The Italian Turbine Passenger Steamer Citta di Palermo

BY DAGNINO ATTILIO

This steamer has just now finished twelve months of service between Naples and Palermo for the Italian State's Railway Department. She is a handsomely fitted and well-appointed vessel, and was designed and built in the shipbuilding yards at Palermo. She is a triple-screw turbine steamer of the following dimensions and particulars:

Length over all	365 feet.
Length between perpendiculars	348 feet.
Breadth, molded	47 feet.
Depth, molded	30 feet.
Displacement	3,445 tons.
Shaft horsepower	12,000
Speed in service	20 knots.
Designed speed on trial	22 knots.

THE CITTA DI PALERMO, ITALY'S FIRST TURBINE-DRIVEN PASSENGER SHIP

Mild steel was used in the construction of the vessel, which fulfills the requirements of Italian shipbuilding and ship surveying regulations. The hull is divided below the main deck into thirty-six watertight compartments, forming double-bottom, peak tanks, holds, oil bunkers, deep tanks, fresh water tanks, engine and boiler rooms, steering-engine room, etc., which make the ship practically unsinkable, even if one or two compartments are flooded.

The propelling machinery, consisting of three sets of Parsons turbines, was manufactured by Messrs. Ansaldo at Sampierdarena. The high-pressure turbine is on the center shaft, and one low-pressure turbine incorporated with an astern turbine on each of the wing shafts. The propeller shafting is of steel turned all over, and two plummer blocks are fitted to each length of shafting. The propellers are of the solid type of manganese bronze, accurately balanced and polished all over, so as to reduce vibration and friction to a minimum.

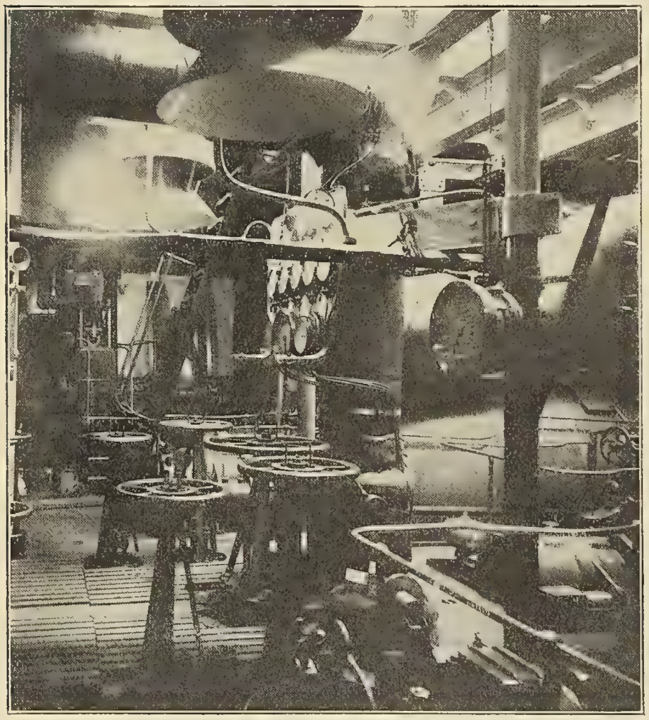
The handles of all valves for the ahead and astern turbines are accessible from the starting platform at the forward end of the engine room, so that an engineer can have complete control of all the machinery. The condensers, of the Uniflux type, are placed alongside the after end of the low-pressure turbines, and are built of steel plates, with strong cast-iron end chambers, with ample cooling surface of 9,000 square feet, and so arranged that the circulating water passes twice through the condensers entering at the bottom. Each condenser is connected to one of the low-pressure turbines by a large steel eduction pipe. The cooling water is supplied to the condensers by two large centrifugal circulating pumps, each driven by a separate reciprocating engine, 11 1/16 inches in diameter by 11 1/16 inches stroke, the suction and delivery pipe being 23 inches diameter; the wheel is 44 inches in diameter and runs at 225 revolutions.

The air pumps are of Weir-Dual's type for wet and dry air suctions, the diameter of each pump is 22 inches and the stroke 16 inches. Pumps are also supplied for forced lubrication of the bearings, and for oil-cooling purposes. There is a full complement of pumps for the bilge, sanitary and fresh-water service of the ship. There are two pairs of Weir's

double-acting feed pumps, each pair being capable of supplying the boilers when the turbines are exerting their full power. The exhaust steam from the auxiliaries is led into a surface heater, through which the feed-water is passed on its way to the boilers. The feed pumps have 13 inches diameter and 26 inches stroke; they are fitted in the forward end of the engine room, together with feed-water filters of the gravitation type. An auxiliary condenser with independent air and circulating pumps is also fitted at the forward end of the engine room.

There are also two large self-lubricating steam-driven dynamo sets. The distilling plant consists of a Bousigueri evaporator, capable of producing from sea-water 20 tons of fresh water per twenty-four hours.

Steam is supplied by ten single-ended boilers, 14 feet 1¼ inches diameter by 11 feet 2⅝ inches long, with three Morison furnaces, 3 feet 10½ inches outside and 3 feet 7⅜ inches inside diameter. The working pressure is 170 pounds per square inch, the grate area 614 square feet for the ten boilers, length of grate 5 feet 9⅜ inches, and heating surface 26,050 square feet. There are 372 tubes in each boiler, with an outside diameter of 2¾ inches and 8 feet 2½ inches in length. The steam chamber contains 3.531 cubic feet, and the stop valve is 4⅝ inches in diameter.



STARTING PLATFORM IN THE ENGINE ROOM OF THE CITTA DI PALERMO

AFTER END OF THE CITTA DI PALERMO'S MAIN TURBINES

The boilers are arranged in three compartments; four in the central and aft compartments and two in the forward compartment; there are two circular funnels which are double, the space between the inner and outer being utilized for ventilating the boiler rooms and stokeholds. The boilers work under Howden's forced draft system, air being provided by five large fans, driven by suitable closed self-lubricating steam engines. See's ejectors are fitted, one for each group of boilers, while for harbor duty two steam oil-heating engines are provided.

The propellers are three-bladed, of 6 feet 6¾ inches in diameter, 5 feet 10 11/16 inches pitch; projected surface for three blades, 20 square feet; developed surface, 22 square feet.

Progressive endurance and full-speed trials were carried out with the vessel, her performance being exceptionally satisfactory throughout. On the full-speed trial she attained a speed of 23.1 knots as the mean of means of six hours of running on the measured mile, from Cape Gallo and Cape Zafferano.

Navigable Model Tests

In view of the valuable results obtained from tests of a navigable model at the Massachusetts Institute of Technology during the last two years, it is gratifying to find that a substantial fund has been received by the Institute to continue and enlarge the experimental work of this kind. Money has been advanced by two prominent New York yachtsmen, Clinton H. Crane and Arthur Curtis James. The former is well known as a designer in yachting circles and the latter is a former commodore of the New York Yacht Club.

The tests will be made on tugboat models, and, according to Prof. C. H. Peabody, under whose supervision the tests will be made, the model itself will be constructed entirely in the shops at the Institute, the work being finished in the spring and the experiments carried out during the summer. The machinery formerly used in the *Froude,* described in the December, 1911, issue, will be transferred to the new tugboat model, and the tests will be made in the Charles River basin in the same manner as was used with the earlier model.

Prof. Peabody states that there are two reasons for taking up the work on tugboats:

First, that the problem of towing appears to have received scant attention, and

Second, that results obtained with the *Froude,* which have not yet been published, show unexpected and important results from such experiments.

It is expected that the work with the tugboat and that already done in towing with the *Froude* will enable placing the towing problem in a clear light. This kind of work can be carried out with certainty and precision, and it is apparently of such a nature that it cannot be accomplished in a model-towing basin.

Marine Gas Engines: Their Design and Application—VI

BY E. N. PERCY

(Concluded from page 10, *Vol. XVII.)*

Heads

At this stage of gas-engine development it is generally acknowledged that large engines must have separate heads. These are made in many forms; they may be a simple water-cooled plate on the head of the engine or a tip just carrying valve gear, etc., or it may form the entire half of the cylinder. In one very successful design the head and cylinder liner are cast in one piece, the outer end liner being turned 1/1000 inch smaller than the cylinder casting and having grooves for rubbing, sliding joints. At the upper end of the head is an ordinary flange, by means of which a water joint is made with a gasket in the usual manner.

A gas-engine cylinder head, particularly of the vertical type, containing valves, inlet and exhaust passages, pockets for ignition devices, etc., makes one of the most complicated pieces of coring with which the founder has to deal. Especially as there should be as few as possible all passages and pockets should be surrounded with water, and the iron forming the walls of each should be kept apart by cores at all points, if possible.

There is probably more trouble with cylinder heads than any other known thing in the mechanical construction of a gas engine. Some of these difficulties are leakage, trouble with gaskets, distorted valve seats, distorted valve guides and poor castings. These troubles are due in part to poorly distributed metal, one portion of the head being of a much heavier construction than another portion, or the walls of passages are allowed to intersect unnecessarily, forming large lumps of metal. If the exhaust valve or the exhaust passage is not entirely surrounded by water trouble is almost certain to result.

The holding-down bolt for the head should never be put through the exhaust passage if it can be helped, or if absolutely necessary should be water-cooled.

With both cylinders and heads of a gas engine it is very important to see that they are absolutely clean from core material. Frequently a batch of burnt or hidden coring will be left in a jacket or in a head, resulting in a hot spot in the cylinder or trouble in the head which cannot be accounted for. Any well-defined hot spot in cylinder or head may be traced through to core material or to poor design; that is to say, so much iron has been put at this particular point that there is not enough water to cool this spot.

It is usual in large gas engines to arrange the head for the four important connections of a gas engine, namely, the inlet pipe, the exhaust, the outgoing water and the ignitor. It is usually crowded for room; the valves are seldom exactly as large as they should be in practical engines, although it is quite possible to make them so, and it is seldom properly cored with all chambers and passages freely able to expand and separated from each other with water on all sides of them. Hence it is easy to see why so much trouble is had with the cylinder heads and why many peculiar designs are adopted to get room for the various connections or apparatus. Among these might be mentioned diagonal valves, pockets and convexed heads. The latter and dome pistons are to be looked upon with suspicion as giving the poorest form of combustion chamber, dome heads and cup pistons giving equal strength in every way with a far better combustion chamber.

Facings for inlet pipes, if well machined, need no gasket, as such air as leaks in will have little effect on the mixture; in any case a beneficial effect. Facings for exhaust pipes should either have ground joints or have fireproof gaskets.

Both passages in the head should be as large and roomy as possible, as should also the valve chamber, in order that a gas traveling in through the comparatively small pipes may be gathered, to some slight extent, between strokes and through the early part of the suction stroke when the velocity of the piston is low.

The placing of the ignitor is a matter governed entirely by practice. Theoretically, it should be placed in the center of the combustion chamber; practically, if so placed, it would not only be soon destroyed by the heat but its delicate parts would be rendered useless almost instantly, and heating up would continually pre-ignite the charges, even as they were being drawn into the cylinder. Hence the ignitor is usually placed at the side of the cylinder or in the head, or even in a water-cooled pocket, some distance back in the head in which it ignites the gas, causing a little flame to shoot out of the pocket to the center of the charge. The water connections to the head should never be through the joint, because it is difficult, if not impossible, to make a joint that will meet the dual conditions of highly-heated gases and cold water. The water may be taken from the cylinder and discharged into the exhaust pipe, as in the case of marine engines, or there may be a cold-water main and hot-water main; the cold water discharging to the various parts of the engine through pipe connections, the hot water issuing from these pipes into funnels in which the flow may be seen and felt as temperature is taken, etc. Also, the overflow pipe will be provided with plug cocks to adjust the flow and temperature for each part of the engine.

Valves

The area of the valves is a matter of varied discussion, and is one in which there is much latitude. For small high-speed automobile type engines it is necessary to make the valves as large as can possibly be put in the cylinders with as little lift as possible, in order to favor the extreme speed of the mechanism.

The velocity of the mixture through the inlet valve varies in practice from 5,000 feet per minute to 20,000 feet per minute, and through the exhaust valve it will frequently go double this amount. The exact amount, of course, is not known, but it is only necessary to observe the fine wire lines across the sides of the valves of many engines to know that the velocities are entirely too high, even if the power of the engine is not materially reduced. With the inlet valve working at a velocity not to exceed 8,000 feet per minute, and the exhaust valve of equal size or even larger, it is perfectly reasonable to suppose that the expanded gases are greater in volume and exit at tremendous velocities and temperatures, often still burning, scoring the valve and seat, heating and deteriorating the stem, causing rapid deterioration of the valve. It is the author's opinion that exhaust valves should be made very much larger than at present, or if this be impracticable that two exhaust valves should be provided.

The lift of the annular valve should be approximately one-fourth of its diameter to obtain full opening of its port, but in case of large valves this places a strain on the mechanism from the acceleration and inertia stresses, which can be much decreased by increasing the size of the valve and reducing the lift, this being especially true with high-speed engines.

Valve springs have very hard work to do, and it should all be well within their elastic limit. This means, in plain words, long springs, many coils of very heavy wire, giving in turn long valve stems with an opportunity to use long guides upon them. The pressure necessary for a valve spring should be

proportional to its work, namely, that of keeping the valve against the tapit at all parts of its stroke, or, in other words, to overcome the inertia of the valve, particularly at the inner end of the valve stroke. By calculating the acceleration and velocity of the valve at the end of its stroke it is possible to know just what amount of work the spring is to do. In addition to this it should be remembered that the spring must overcome the inertia of the valve at all points of movement on the return stroke, and must come to an instantaneous stop from its highest velocity as it seats. Some very complicated pieces of mechanism are designed to reduce this velocity just at the point of seating, but their theoretical good effect has never overbalanced their complication, and practice has shown that it is perfectly safe and much cheaper to seat the valve at highest velocity without a guard to acceleration stress.

It is generally conceded that both valves should be mechanically moved on all types of engines, and that it primarily is a means of saving to make them otherwise. A cam machine, from its very nature, is neater, and the author is of the opinion that eccentrics can and will be used to operate gas-engine valves in the near future by the aid of acceleration bell cranks so arranged as to get all equal and open relatively slowly.

The cooling of the inlet valve has never been a serious problem, as the incoming mixture has always been sufficient for the purpose. The exhaust valve is a serious problem on all engines, and if one can be removed quickly from an engine which has been running for several hours consecutively it will be found to appear red-hot; referring, of course, to valves which are not cooled.

With large engines having valves upwards of 4 inches in diameter it is customary to make them water-cooled. The greatest difficulty with water-cooled valves is the water joint. This has been tried variously with telescope joints, pendulum joints, etc. The most satisfactory, probably, is a short piece of hose; it is practical, works perfectly and looks neat, especially if bound on the ends with a brass binding or ferrule.

Many new devices have been used with gas-engine valves, either in the form of insertible rings or bushings or a complete cage in which the valve works. A serious objection to the valve cage has always been the double joint necessary, but since the advent of copper gaskets the double joint has been found an entirely practical proposition. The most modern practice with valve cages is to have them water-cooled, thus having the valve in a removable water-cooled cage, in which it can be ground, lined up and otherwise looked after.

Unless carefully water-cooled the valve is more or less apt to distort, especially in large engines, but when carefully jacketed with water it makes an ideal piece of construction, and is now extensively used on high-grade engines.

In Germany, and also in America, many makers of high-grade engines of the stationary type have their valves erected in cages, the advantage being obvious. There are many kinds of cages, and every firm that has taken them up has passed through a costly but useful experiment, it being by no means as simple to construct valve cages as it appears. The designer, in putting in his first valve cages, will probably find it impossible to keep the valves ground in, because of the distorting of the seat, due to the cage being unsymmetrical or one side being hotter than the other, or the joints being improperly made, or the cage being too close or too slack to fit in the tube; also, he may find that the valve stem binds, due to its being cooler on one side than on the other, or to the guide being insufficiently cooled. All these are problems which can be settled only by experiments of the most expensive kind, but as soon as thoroughly developed and understood by a firm, a valve cage is the most valuable asset a gas-engine man can have.

Piston

Pistons are made in various forms, but in general are much heavier than with steam engines, and must be more carefully designed as regards distribution of metal, etc.

The gas-engine piston works under a much wider range of temperature, under higher pressures, greater shocks and with mediums which escape much more easily than steam, and in the smaller-size engines are not water-cooled. With the diagonal, single-acting gas engine it has been general practice to provide a bucket piston. On either horizontal or vertical engines, late practice has tended strongly towards the use of pistons so constructed that the wrist pin is external to the cylinder, and piston is in plain view and easily accessible for adjustment, lubrication and examination while running. This feature involves various constructions, ranging from an extension of the piston outside of the cylinder with large orifices on each side to an ordinary double-head piston within the cylinder, connecting with an ordinary cross-head by means of a piston rod. Besides the bucket piston we have the double-ended piston, constructed to operate on the end of the piston rod. This piston may be hollow or solid, and may or may not be water-cooled. It is found in both single and double-acting engines, and is made in various forms, namely, with flat, parallel faces, with dome faces, and occasionally with concaved faces. Bucket pistons are frequently made with concaved faces in order to give the combustion chamber an almost spherical form at the moment of ignition, also as it provides additional combustion space without lowering the wrist pin, the entire engine is somewhat shortened, also the concave piston head is stronger than a flat head.

Piston velocity in the gas engine does not vary a great deal in large, heavy engines designed primarily for durability and runs from 600 feet to 800 feet per minute. In engines designed primarily for speed and lightness, as in automobiles, motor boats and air ships, it may run as high as 2,000 feet successfully, but these high speeds call for larger pipes, finer workmanship and careful allowances for expansion.

Lubrication should be carefully attended to in all cases, but most particularly in high-speed engines. The pressures on pistons during a cycle will vary from 10 to 14 pounds negative to 300, 400 and 500 pounds positive pressure. As the average or mean effect of pressure is only 50 to 75 pounds, and the compression 75 to 100 pounds, it is easy to understand that the maximum pressures must be of short duration, and have much the same effect on the piston as a blow. As this shock usually takes place on or before the center, especially at high speed, it is easy to realize the tremendous stresses to which it is subjected. In connection to this is a special consideration of the off-set crank in addition to those hithertofore referred to. With the off-set crank the piston has attained some little velocity when the explosion takes place, and the force of the explosion can be expended with the crank at some point of perceptible moment of revolution, and this shock, instead of expending itself on brasses and piston, tends to give the engine a decided impetus ahead; also the power of explosion is received and made use of coincident with this occurrence, and the gases have lost temperature, the pressure thus being an important point, as it is only necessary to examine an average indicator card to see that this loss generally takes place with a tremendous rapidity. While the effect on the power is not probably great it will have a perceptible effect upon the economy and makes a pronounced difference in the durability of the engine, particularly so far as the piston and piston pin are concerned.

The piston rings are subject to much discussion, being a detail developed purely from practice and experience and having no rules or theoretical formulæ in any way applicable. The number of them is governed largely by the space available between the piston pin and the base of the piston, the thickness of them by the diameter of the piston and amount of strain desired, the width of them by the diameter of the piston, the

pressure for which designed and the number of rings which it is desired to lay between the piston pin and the face of the piston. In the case of the piston in which there is no pin, it is purely a matter of experience and the number which can be put between the piston faces.

Under identical conditions practice of the above details varies widely with the different forms and equally good results seem to be obtained. Patent rings of complicated or built-up construction do not seem to have survived in any form in the ring market. Probably the eccentric ring is used more than any other. Very cheap engines have those rings made with a simple diagonal slash in same, which is good enough for a practical large-size engine, but will affect the economy and compression considerably in the course of time. More careful builders cut the ring with the mortars, and the joint is carefully lapped half and half.

Eccentric rings are usually made about twice the thickness on the thick side of the thinnest side. The width may be approximately twice the average thickness, although some makers vary considerably from this. The usual method of making the rings is to turn them inside and out from the stock, leaving the outside about 1/32 inch large. Makers of cheap engines do not do this but turn the ring directly to size in the stock. The end of the stock is carefully faced and finished and the ring is cut off. The ring is then jointed and set in a chuck, carefully centered and backed against a face plate, large factories having a machine for this purpose, smaller factories or jobbers of large engines doing the work on a cut lathe. The ring is then sprung together, held in that position, carefully turned on the outside to a trifle over the diameter, and the remaining top fixed to gage. The ring is then taken to bench and the end fitted to piston.

The tension on the ring, its friction against the side of the cylinder, etc., are entirely a matter of experience, and cannot be detailed here. The rings are finished on the corners, either with a fine file or are hand-centered. It is customary with many designers to run the top of the ring through, to or over the counterbore. This is unnecessary and objectionable. In the first place, if the ring runs over the counterbore it is very apt to be collapsed by the pressure, also it gradually collects soot until the groove is full, hiding the ring and cutting the cylinder.

Practice has shown that it is only necessary to run the end of the piston over the counterbore at either end of the cylinder and the cylinder will thus be borne down and practically the same power will be obtained. The travel of the ring wears a difference between them, being a gradual taper extending from the center of the cylinder, which naturally wears largest to the counterbore and not a shoulder, as is theoretically supposed, forming at the end of the travel of the rings.

With large engines the cylinders are usually finished on the lathe with cutting tools, as with steam engines and pistons in the same manner, being of fairly loose fit with each other, between 1/32 and 1/64 inch clearance. With small engines the cylinders and pistons are carefully ground, the lower end of the piston being ground 1/100 inch larger than the upper end to allow for differences in expansion.

The grinding of large cylinders, pistons, and, for that matter also, of pins and bearings is a doubtful advantage in practical engineering. The first objection is that the cost is not counterbalanced by the result obtained, especially when one considers that the run of a few weeks or even days removes the traces of grinding and brings the pins, pistons, cylinders, etc., to a condition that could have easily been reached in the first place with lathe tools. Furthermore, in a cylinder which has been finished with a bearing tool, if a small chip be started by a sharp corner or a rough or overheated ring, and one which fits too tightly, the chip is very likely to end at one of the minute tool marks rather than score the whole length of the cylinder. Moreover, with large engines the fine fits, which can be obtained with grinding between the pistons and cylinders, do not seem desirable, as the engine works better when fit more loosely. This is due to the fact that the distribution in casting of practical designs is frequently three or four, or even more, times the limits which are obtained by this fine method of finishing cylinders.

The wrist pin has a bearing to be taken up in connection with connecting rods, but in regard to its relation with the piston some reference should be made to the best methods in use. The cheapest way to place a piston pin in any kind of pocket piston engine is to fasten it solidly to the connecting rod, and having it turn in bushings set in each side of the piston; but this is a most objectionable method, because while the pin is theoretically not subject to a great deal of wear, in actual practice it is found that its bearings have to withstand considerable. This is probably not so much due to wear as to the constant action of the piston upon it, which increases as lost motion accumulates, until the bushings receive a very considerable battering with every stroke of the engine.

One of the most satisfactory methods is to set the pin solidly in the piston and providing split brasses in the center, with a regular marine design adjustable from the lower side. It is customary to set the pin in plain bored hole with key on one side and set screws on under side, the hub on both sides.

There should be grooves for lubrication on any kind of piston, whereby the oil may creep to all parts of the piston, and in the case of pocket piston at least one snap ring should be provided below the oil grooves to keep the oil from dropping out of the cylinder. In the case of pocket pistons it is customary either to make the piston pin hollow or to drill it from end to end, and then to so drill at right angles that the lubricating oil reaches all parts of the piston pin. This lubricating oil the piston takes from the piston oil grooves. Piston rods may be put on each side of same, as in the steam engine, excepting that nuts cannot be used unless they are inside of the water-jacket or in other parts protected from the heat.

In the case of the double-acting engine the piston is also hollow and filled with water supplied through a hollow rod and carefully lubricated, usually by means of an oil lantern in the water-cooled stuffing basket.

An interesting feat in the casting of Monel metal was recently accomplished in the foundry of the Bayonne Casting Company, Bayonne, N. J., where a four-bladed propeller wheel 16 feet in diameter was cast in somewhat less than an hour. Fully 18,000 pounds of the metal was required to allow for gates and finish, the melting temperature being about 2,500 F., and the finished weight about 14,000 pounds. The wheel, because of its greater strength and freedom from corrosion, is to take the place of a steel wheel on the steamship *Madison*, of the Old Dominion Line.

The Bureau of Navigation reports that 61 sail and steam vesels of 3,113 gross tons were built in the United States and officially numbered during the month of December, 1911. About 70 percent of this tonnage consisted of steel steam vessels constructed on the Atlantic and Gulf coasts.

For the six months ending Dec. 31, 1911, the Bureau of Navigation reports 612 sail and steam vessels of 82,267 gross tons were built and officially numbered. As compared with the corresponding period in the preceding year there was a decrease of approximately 40 percent, the total tonnage built and officially numbered in the six months ending Dec. 31, 1910, being 137,568.

Twenty Thousand-Ton Pontoon Floating Dry-Dock

In a paper presnted before the nineteenth annual meeting of the Society of Naval Architects and Marine Engineers by Messrs. Frank E. Kirby and William T. Donnelly, the new marine terminal of the Grand Trunk Pacific Railway, Prince Rupert, B. C., was fully described. An abstract of this paper was published on page 5 of our January issue, which contained a description of the pier work, launching platform, power plant, boiler, blacksmith, machine and woodworking shops and the administration buildings. The main feature of the terminal, however, is a 20,000-ton pontoon floating dry dock, details of which have been reserved for publication in detail in this issue so that they can be better explained by reference to the drawings.

This dock is to have an over-all length on keel blocks of 604 feet 4 inches, a clear width of 100 feet and a width over all of 130 feet. The lifting power is the aggregate of twelve pontoons of timber construction, each 130 feet long, corresponding to the width of the dock, 44 feet wide in a direction corresponding to the length of the dock and 15 feet deep. These pontoons are to be united by steel side walls or wings 38 feet high, 15 feet wide at the bottom and 10 feet wide at the top, the walls being divided so that the whole structure may be used under ordinary conditions as three separate docks, one of six pontoons, with an over-all length of 269 feet, and two of three pontoons each, with an over-all length of 164 feet each. The largest commercial ship upon the Pacific Coast at the present time is the *Minnesota,* the outline of which is shown on the dock. This vessel would have a dead weight in ordinary unloaded condition of approximately 18,000 tons.

The machinery for pumping the dock will consist of centrifugal pumps operated by electric motors, the capacity of the equipment being sufficient to pump the entire lifting power of the dock in less than two hours. A detailed description of the pumping machinery will be given later.

The structure as a whole is secured to the shore by the engagement of clamps on the dock with a vertical truss secured to the pile platform or pier in such a way that it is free to rise and fall with the tide, and when being raised or lowered with a ship. The location of these attachments is such that when it is desired to use the dock in three separate sections, the bow section may be detached and moved around the corner of the pier work alongside the platform, and secured in the same manner as provided for in its original position. To make the other two sections available as separate docks it is only necessary to detach the middle section, comprising six pontoons, from the pier work and advance it the length of the detached section, when the sliding clamps upon the wings will ccincide with those used for the previous section when the dock was operated as a whole. This will allow ample space between the center and stern sections for the overhang without interference of vessels which may be docked on them.

As the feature of a sectional dock to be used as a whole or separately is somewhat new, it is desired to call attention to the fact that the three largest commercial docks in the United States, namely, the 10,000-ton floating dry dock of the Tietjen & Lang Dry Dock Company, built in 1900, the 12,000-ton dock of the Morse Dry Dock Company, built in 1902 (both in New York harbor), and the 10,000-ton dock of the port of Portland, Portland, Ore., are sectional docks in five sections each. All of these docks are of timber construction and are giving excellent service.

Pontoons

As previously stated, the pontoons for this dock are to be twelve in number, constructed entirely of timber (Fig. 3). They are to be 130 feet by 44 feet by 15 feet deep, with a crown of 3 inches at the center, and will have fifteen trusses spaced on 3-foot centers. There will be a center watertight bulkhead 12 inches thick, and above this bulkhead the center will be reinforced for carrying keel blocks. There will be three partial bulkheads on each side to stiffen the pontoons. All diagonal braces are heavily reinforced with anchor stocks. The arch brace is made up of planking through-bolted with screw bolts, and is intended to take the reverse stresses when the dock is floating light. This is a considerable amount when it is considered that the wings are superimposed weights carried at the extreme ends of the trusses, supported by an evenly distributed pressure over the entire bottom. Six by 12-inch deck beams are worked across the upper and lower truss members, carrying the 5-inch deck and bottom planking parallel to, and reinforcing the truss members for the maximum stress. This construction also makes it possible to get in double vertical tie rods alongside of bulkheads in such a manner that they may be replaced at any time. The whole structure is made watertight by calking with white pine wedges.

To protect the exterior from toredo and other marine worms, it is first thoroughly graved with tar poisoned with arsenic, then sheathed with two layers of hair felt, each thoroughly saturated with tar and arsenic, and then with creosoted lumber, also treated with arsenic and thoroughly secured with galvanized nails. This treatment, together with the facility for inspection afforded by the possibility of detaching and docking any pontoon, has been found to give satisfactory protection.

Each pontoon will require approximately 330,000 board feet of lumber, or a total, including outrigger or prow on the end pontoons, of 4,000,000 board feet. The entire bill of lumber will be of selected grade of Oregon pine or Douglas fir.

As previously stated, it is the intention to have these pontoons built upon the launching platform under the building shed, using tools and equipment provided for the plant. Sufficient room has been allowed to build three pontoons at the same time. As soon as they are launched they will be moved into the basin between the pier and dry dock platform, and temporarily united together in correct relative position by timber clamps, when they will be ready for the erection of the steel wings.

For further information relative to the use of wood for the construction of floating dry docks, parties interested are referred to a paper on "Floating Dry Docks in the United States —Relative Value of Wood and Steel for Their Construction," appearing in the *Proceedings* for 1910 of the Society of Naval Architects and Marine Engineers.

Steel Wings

By referring to Fig. 2, showing the completed structure and the design of the wing trusses and plating, a general idea will be gained of the construction of the wings. They consist of channel and angle frames on 3-foot centers corresponding to the trusses of the pontoons, and a covering of plating varying in thickness from one-half to five-sixteenths inch. The construction is greatly facilitated by reinforcing the plating against water pressure on the outside by horizontal angles. This does away entirely with troublesome intercostal connections and gives the material used very much greater value in the construction as a whole.

By referring to the table of weights it will be seen that there are required about 2,200 tons of steel. Where the wing meets the deck of the pontoon there is a steel shoe secured to the frame of each pontoon and a corresponding shoe riveted to each frame of the wing. These are connected together by a

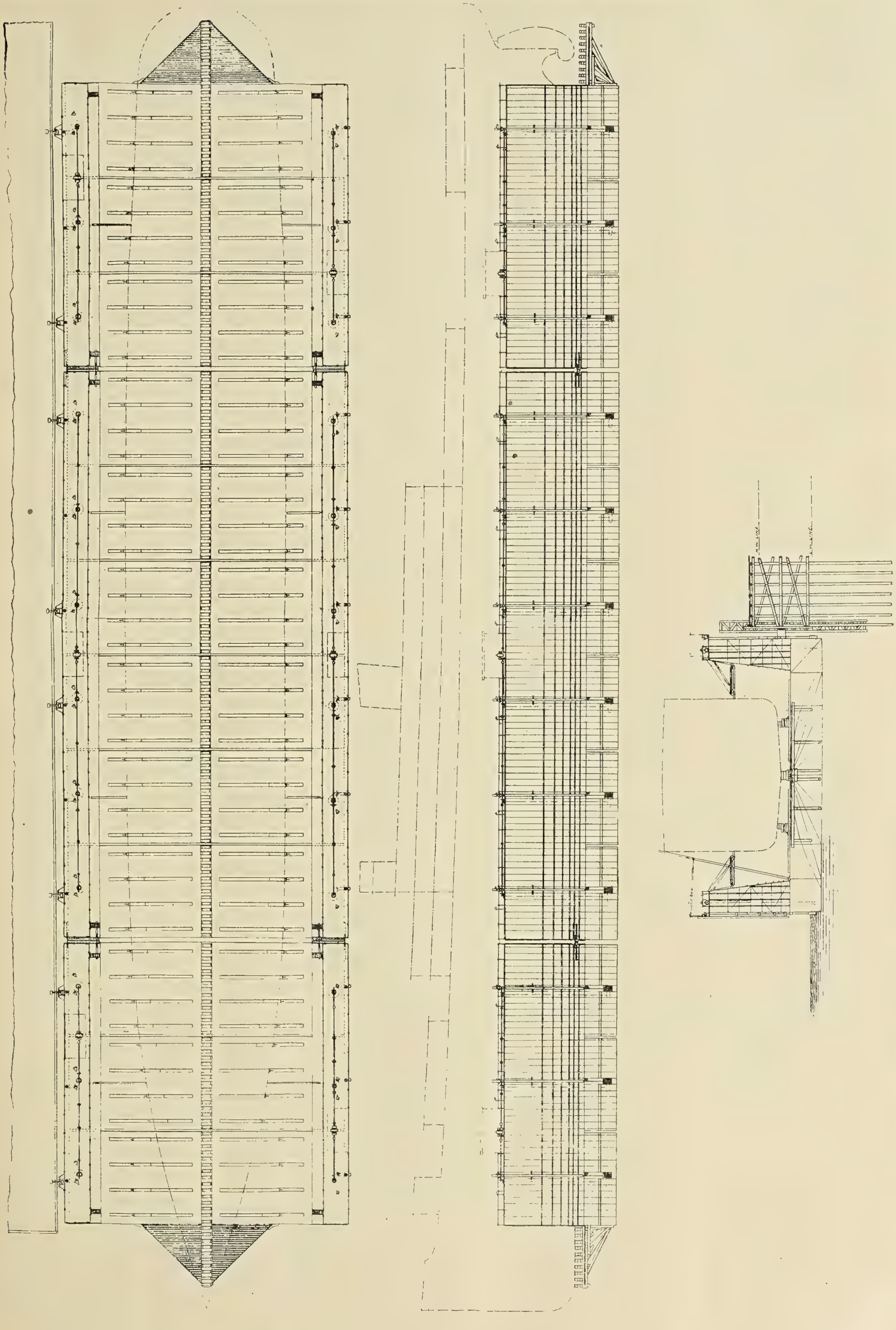


FIG. 1.—PLAN, ELEVATION AND CROSS SECTION OF 20,000-TON PONTOON FLOATING DRY-DOCK FOR THE MARINE TERMINAL OF THE GRAND TRUNK PACIFIC RAILWAY, PRINCE RUPERT, BRITISH COLUMBIA

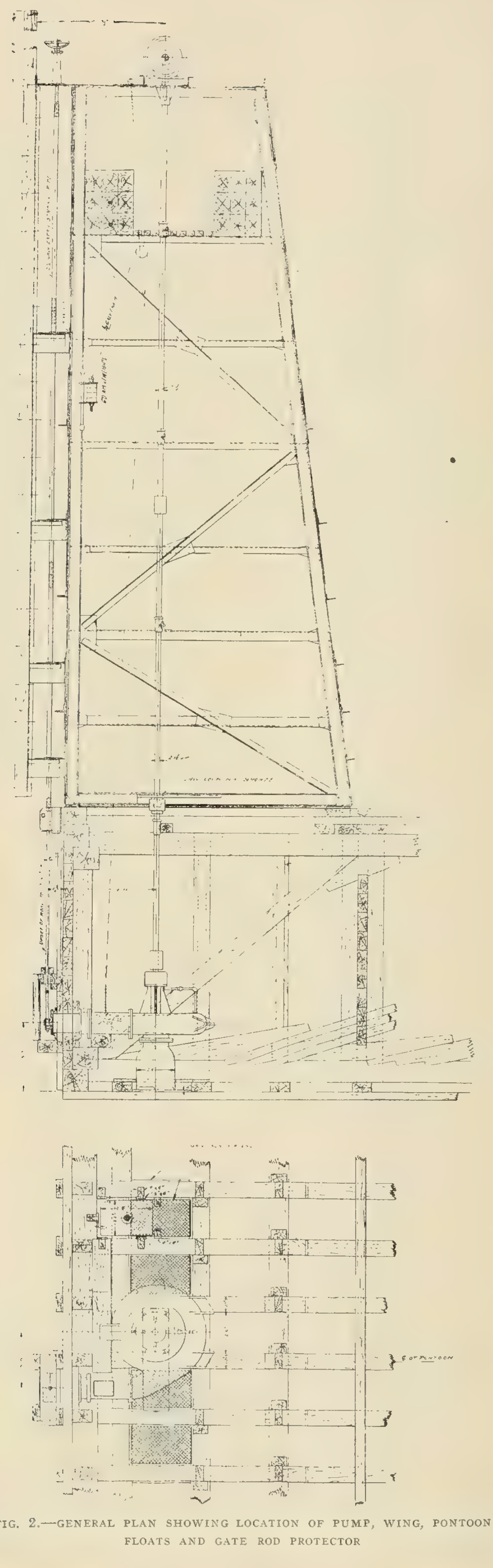


FIG. 2.—GENERAL PLAN SHOWING LOCATION OF PUMP, WING, PONTOON FLOATS AND GATE ROD PROTECTOR

steel link about 15 inches long and pins, the upper one of which is tapered one-half inch to the foot. The driving of this pin wedges the pontoon and wing together. At the point of contact the bottom of the wing is reinforced by a 12 by ½-inch plate, and made watertight by canvas packing saturated with red lead. On the outer side of the wing the method of securing is similar, except that the shoe on the pontoon is replaced by a cast steel strap through-bolted to the pontoon.

Provision is made for multiple punching on uniform centers of 3 inches and 6 inches throughout, and the intention is to have the material fabricated in Europe or the eastern part of the United States, all frames assembled and shipped by water to Prince Rupert. The erection of the first section is to be commenced as soon as the first three pontoons are launched, the compressed air machinery of the plant being used for pneumatic riveting.

Pumping Machinery

The dock will be pumped by twenty-four (24) 12-inch centrifugal pumps, one in each end of each pontoon. By referring to Fig. 2 the general arrangement and detailed construction of these pumps will be seen. The pump suction will take water from the bottom of the pontoon, the suction being protected by a liberal area of screen. Delivery will be directly through the flood gate used in lowering the dock.

The pumps will operate at approximately 275 revolutions per minute, being driven by a vertical shaft. All the pumps on each side of each section will be driven through gearing and horizontal shafting by one electric motor, as shown in Fig. 2. A jaw coupling is provided in the wing at about the level of the top of the pontoon for disconnecting the vertical shaft when the pontoon is removed for self-docking.

There will also be seen in Fig. 2 the indicator for determining the level of water in the wings. This consists of a counterweighted float in vertical guides and a vertical rod extending through the deck of the wing. As the water enters the wing the float rises, and the height of the rod above the deck will indicate the depth of the water in the wings.

A similar device, not shown, is provided to show the depth of the water in the pontoon. The flood gates are operated to control the lowering of the dock and also to control the pumping collectively and individually of the different pumps, it being understood that with the pumps running no water will be delivered if the flood gates are entirely closed, and that, by a regulation of the gates without altering the speed of the pumps, any degree of control or any distribution of control can be accomplished. In case one side is rising too rapidly the partial closing of the gate on that side, without disturbing the operation of the machinery, will affect the control, or the gates may be left at the same opening and the machinery stopped.

By this method a much quicker and more powerful control may be obtained, as not only will the discharge of water from the dock stop, but will immediately commence to enter, thus doubling the power of control which would be obtained by closing the gates.

Electrical Equipment

As previously explained, the group of pumps on each side of each section of the dock will be operated through horizontal and vertical shafting by one electric motor. Thus for the two smaller sections of three pontoons each there will be required four 100-horsepower motors, and for the larger section of six pontoons there will be required two 200-horsepower motors. The motors are to be alternating-current, three-phase, 25-cycle, 550-volt, and will operate at approximately 500 revolutions per minute. They are to have wound rotors and slip rings for variable speed control. The armature shaft is to be extended on both ends, and will operate the distribution shafts through reduction gearing at a speed of approximately 275 revolutions per minute.

There will be two motors on each section, one on each wing.

The power circuit on the pier is connected to the power circuits on the sections by flexible cables. The power circuits of each section are independent from the main circuit, so that each section receives its power independently, but the control system is to be so arranged that the two motors on any section may be operated from one master panel or the combination of any two sections may be operated from the master panel on either of the two sections, and, lastly, when all three sections are used together all six motors are to be controlled from the master panel on the middle or larger section.

and on one side of each section there will be provided an electrically-driven air compressor having a capacity of 500 cubic feet per minute. The air will be delivered to a receiver in the wing below, and from this to air piping carried along the bottom to each side of the wing, with multiple outlets for the connection of air hose to the pneumatic tools. Provision will also be made for connection between the sections of the dock when they are operating together.

Electric current for operating the air compressors will be taken from the circuits supplying the motors for pumping the dock, and as air will be used only after the dock is pumped up the capacity of these circuits will be more than ample.

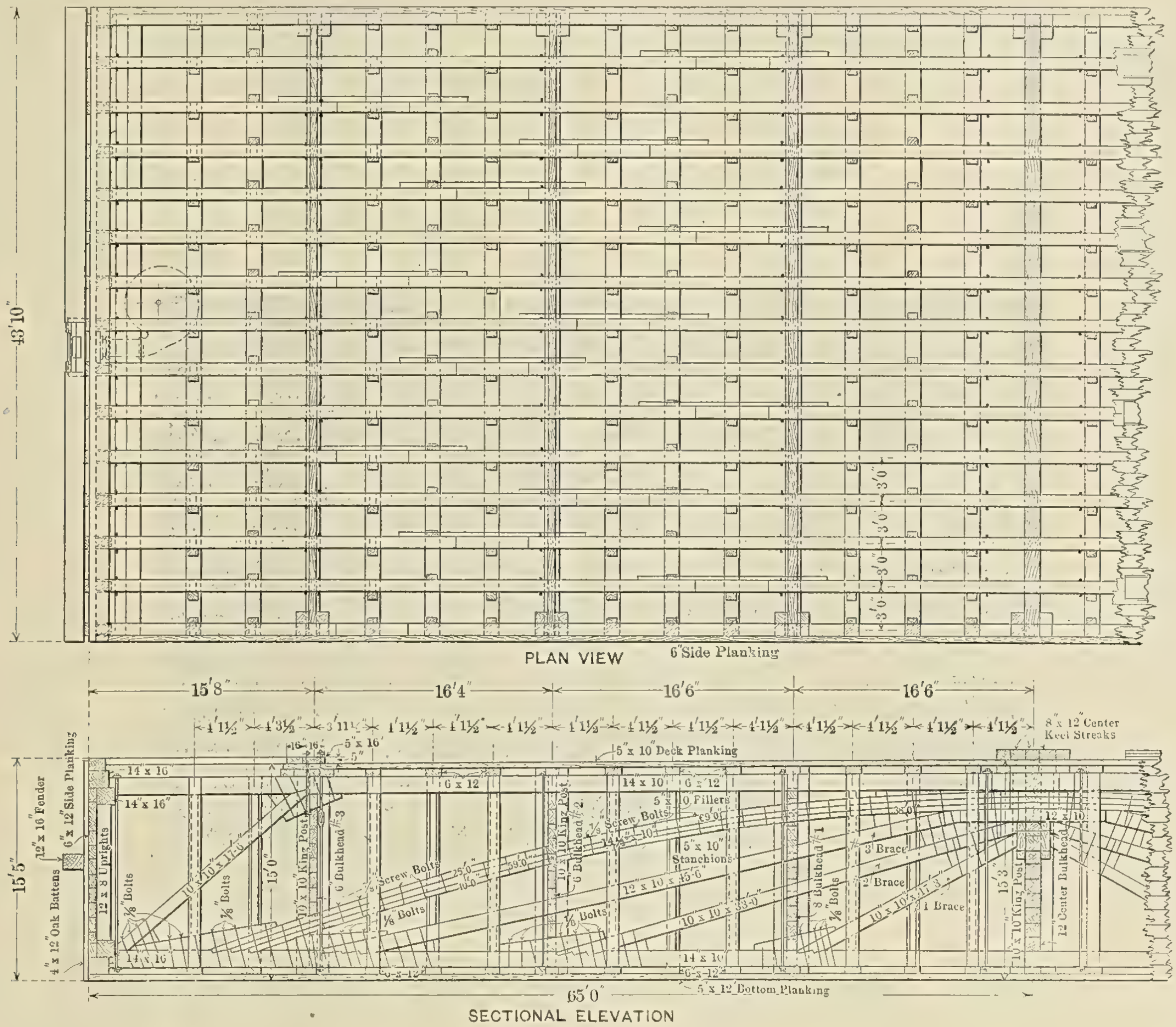


FIG. 3.—HALF PLAN AND SECTION OF FLOATING PONTOON

Master Panel

The master panel is to consist of a panel or drum having suitable contacts or switches for independently starting or stopping any of the motors. The starting or stopping of any one motor or a number of motors will not affect other motors at rest or in operation. The provision is also to be made for operating any or all motors at one-half, three-quarters and full speed.

Compressed Air Equipment

While steam-driven air compressors are provided in the power plant to furnish compressed air for the shops, it was deemed advisable on account of difficulty due to the extreme rise and fall of tide, to make flexible air connections to the floating dry dock and to provide an electrically-driven air compressor upon each section.

Machinery houses are provided for the different sections,

Operating Equipment, Bilge Blocks, Keel Blocks, Etc.

Referring to Fig. 1, there will be seen the arrangement of keel blocks and bilge blocks. The keel blocks are to be of oak, 12 by 16 inches by 4 feet long, and are to have a height of 4 feet. The bilge blocks are to be on about 12-foot centers and operated according to the usual American practice by means of a galvanized chain on the floor of the dock and a leading rope through 6-inch sheaves secured to the wing near the deck, leading up and returning over the pipe railing around the tops of the wings. The return rope leads to the tail dog, and is used in tripping the dog and pulling the block out when the ship is leaving the dock. The bilge blocks are provided with an elevating screw, which has been found to be of great service for removing blocks one at a time for painting.

Steam Turbines for Auxiliary Purposes on Board Ship

BY ERNEST N. JANSON

Steam turbines of various descriptions and types are becoming more and more the choice as motors for driving auxiliary machinery on board ship. While this applies in a general way to modern steamships of the mercantile marine class, it applies particularly, and almost without exception, to naval vessels. But although the service of the steam turbine is continually making inroads on the fields only a few years ago independently held by the reciprocating engine, its application is yet restricted principally to such auxiliaries in connection with which its utility is commercially and technically expedient.

Advantages

Some of the advantages recognized to pertain to turbine propulsion will be observed to apply also to auxiliary turbine drives. Among those standing out most prominently with respect to the turbine, however, as an auxiliary are:

1. Good steam economy at designed loads.
2. Economy in floor space and lightness in weight.
3. Moderate initial cost and maintenance, no waste of oil or renewal of packing.
4. Adaptability for erection in both horizontal and vertical positions.
5. Reliability at high rotative speeds with inappreciable vibration.
6. Sealed enclosures of operating parts and automatic forced lubrication.
7. Simplicity in construction, easy attendance and few adjustments.
8. No oil used on parts coming in contact with steam, therefore no contamination of the feed-water.
9. Cleanliness in the absence of lubricating oil.

Applications

As stated before the employment of the steam turbine for the operation of auxiliary machinery now constitutes an important detail in machinery installations on board ship. Its application is, however, limited, owing to certain circumstances prevailing on board ship, such as do not apply when used in stationary plants. The nature of these facts will be readily understood by the references which follow later.

Principal applications found for steam turbines driving auxiliary machinery on board ship are:

1. Electric generating sets.
2. Forced draft blowers.
3. Special types of rotary air pumps.
4. Centrifugal pumps.
5. Air compressors.
6. Torpedo-driving mechanism.

The most important, and by far the most extensive, is the application found under heading 1. All modern steamers, whether for river, lake, sound or ocean, together with all vessels for naval purposes of all descriptions, steamers in the lighthouse service, Fish Commission, Coast and Geodetic Survey, and a large part of those coming under the quartermaster of the War Department, are now equipped with an electric light and power plant.

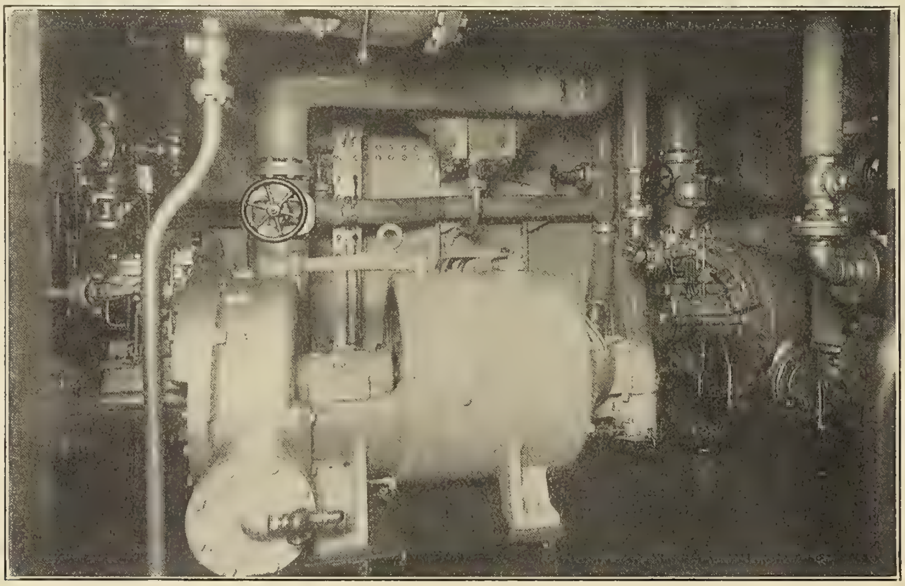


FIG. 1.—CURTIS TURBINE LIGHTING SET INSTALLED ON THE ALABAMA

The electric plant, however, is not only for the purpose of furnishing light to the various rooms and compartments, but also for the generation of current to supply adequately a number of different motors used throughout the ship. Such motors are used for driving ventilating fans, ammunition hoists, pumps, turret machinery, elevators, winches, cranes and tools. In consequence of the very extensive use for electricity on board ship electric plants have grown correspondingly large, and both the number and size of turbines for their operation have increased accordingly.

Although forced draft blowers when used in boiler installations are yet, generally speaking, in the majority of cases, driven by reciprocating engines of special design, and in quite a number of instances by electric motors, the direct-turbine drive, in special arrangements, such, for instance, as exist in torpedo boat destroyers, have particular advantages, and therefore invariably call for this combination. In this class of ships the necessity has fostered the advantage, and

lies in the fact that the blower, placed on the underside of the deck, connects directly with the ventilating cowl. As this is a place rather inconvenient of access, and therefore eliminates the use of machinery requiring much attention and frequent adjustment, as well as one where the temperature may rise to a degree where the successful operation of electric motors would be very questionable, the application of a small size, fairly economical, turbine becomes desirable for several reasons. In this connection, and as one of the reasons, the question of diameter of fan impeller, and thus of casing and space occupied, plays an important part in installations of this kind. The high pressures, of from 5 to 6 inches, required on the full-speed trials of this class of boats, call for high peripheral speed of impeller. This may be obtained either by a small diameter and high number of revolutions, which is suitable to the turbine, or by large diameter with comparatively slow revolutions, such as are characteristic of reciprocating engines.

While the steam turbine has particular merit when used in conjunction with the two foregoing auxiliaries, its utility has also become very marked as a drive in connection with rotary air pumps and air compressors. Turbo-circulating and feed pumps are also used, but less frequently than in the cases previously referred to.

Economic Considerations

As is well known, the principal items in the operation of a steam turbine, which directly influence the steam economy or the steam weight used per brake-horsepower per hour, are the speed of the vanes and the degree of expansion of the steam. Running at the speed of revolutions, which insures the proper vane speed for maximum economy, together with a wide range of steam expansion, are the ideal conditions under which the steam turbine may be operated. This condition is, however, only rarely met with when operating ship auxiliaries on board naval vessels, but invariably in ships of the merchant class, which, unlike the naval vessel, run the greater part of the time at full speed. When running at much reduced speed not only the main engine power is curtailed, but the output of blowers and pumps is correspondingly reduced by cutting down the speed of revolutions of the turbine. By so doing a very material loss of steam economy, as compared with designed (full) speed runs, ensues. The turbine-driven electric unit differs in this essential respect very materially. The "load-water rate curve," which is a characteristic of steam consumption at varying loads, is rather flat even within such limits as from one-half load up to 50 percent overload, depending largely upon the fact that said variation may be obtained with practically constant revolutions, steam pressure and vacuum. The quantity of steam admitted is regulated by governing devices, and corresponds to any electric resistance demanded by conditions of operation. In this respect the turbine drive is superior to that of the reciprocating engine, and due to considerable flexibility with respect to overload, its usefulness is materially increased.

The average steam economy of the small-power turbine, direct connected, is between 30 and 70 pounds running non-condensing, with horsepower and revolutions varying. Geared turbines show superior economy.

The usual arrangement of exhaust from turbine blowers or pumps is such that this exhaust is used for heating the feed-water, and therefore allowed to issue against a comparatively high-pressure, ranging from atmospheric to about 10 pounds gage. From this cause alone a very high steam consumption will be shown; but, purposely, so to speak, arranged for in order to obtain a high-temperature heating agent in the feed heater. The foregoing, however, does not include turbines driving the generators, as they usually exhaust into their own condensers, in which are maintained a vacuum varying from 25 to 27 inches.

Types of Turbines

Among the turbines most commonly used for auxiliary purposes, both here and abroad, we note the following well-known makes: Parsons, De Laval, Curtis, Schulz, Rateau, Terry, Elektra, Sturtevant, Kerr and others. Some of the foregoing types are constructionally adapted only when in large units of above 500 or 600 horsepower, and as such are used in auxiliary plants aboard ship for the generation of electric power of great magnitude. We find such installations in the *Lusitania*, with four 375 kilowatts, 1,200 revolutions per minute Parsons turbo-generating sets, and in the *Mauretania* with a similar installation. The new White Star Line steamers *Olympia* and *Titanic*, on the contrary, have each four independent reciprocating engine-driven electric units of about 580 horsepower each, 325 revolutions per minute.

Curtis Turbine

As is well known this type of turbine is of the pure impulse type. The principle of operation consists essentially in steam velocity being imparted to the steam by expansion in suitable

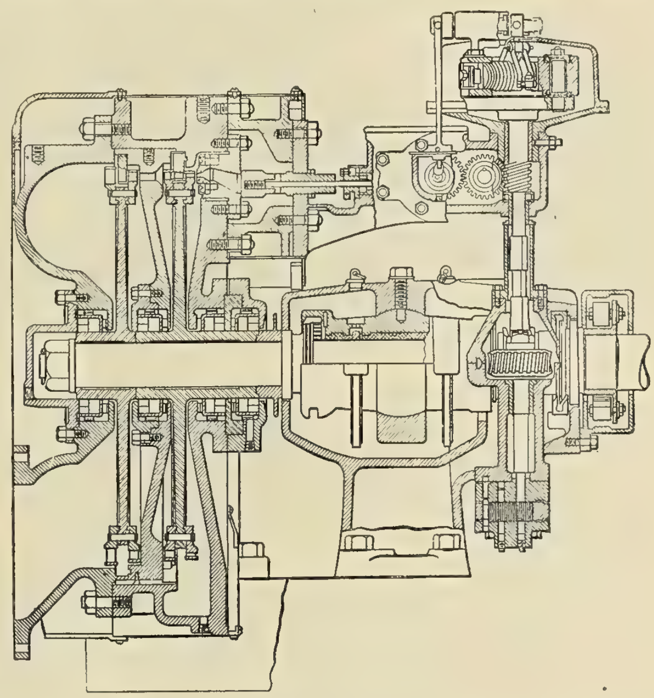


FIG. 2.—SECTION OF TWO-STAGE, NON-CONDENSING CURTIS TURBINE, 160 HORSEPOWER

nozzles. After leaving the nozzles the steam jets pass successively through two or more rows of vanes on the rotor, being deflected alternately by reversed vanes on the stationary element. The kinetic energy in the steam is thus fractionally abstracted and given up to each rotating element. The number of wheels and rows of vanes are governed by the degree of expansion and peripheral velocity, which, by various conditions and mechanical expediencies, may be considered practicable.

The turbines built by the General Electric Company, of Schenectady, N. Y., and now extensively used as prime movers for driving dynamos in ship installations, are made in sizes from 5 kilowatts up to 300 kilowatts. They are made when so used with horizontal shafts and run either condensing or non-condensing, the former condition generally prevailing. The United States navy stipulate and require in sizes below 25 kilowatts satisfactory operation when exhausting against a back pressure of 20 pounds above atmosphere. Direct connection by means of solid coupling is used between the turbine and the armature of the generator, the revolutions of

the wheel varying from 5,000 for the 5-kilowatt machine to 2,400 for a 100-kilowatt and 1,500 for 300-kilowatt turbines. The steam pressure is normally about 200 pounds, and the turbines ordinarily run condensing, but must be capable of running full load with 5 pounds back pressure. The water consumption per kilowatt-hour, when running full load, varies along a range of from 55 pounds for the 5-kilowatt turbines to about 29.5 pounds for a 100-kilowatt unit, and 26.5 pounds for 300-kilowatt units at 27 inches vacuum. Generating sets of 300-kilowatt capacity are now being placed in some of the latest battleships.

With respect to design the Curtis turbine is compact, with all of its parts self-contained, and constructionally incorporates features of durability as well as reliability. The rotor wheels are perfectly balanced and are made of steel. The cylindrical wheel casing is lagged with Russia iron, and is supported on a bedplate, which is common to both turbine and generator.

The buckets are made of an extruded nickel-bronze material,

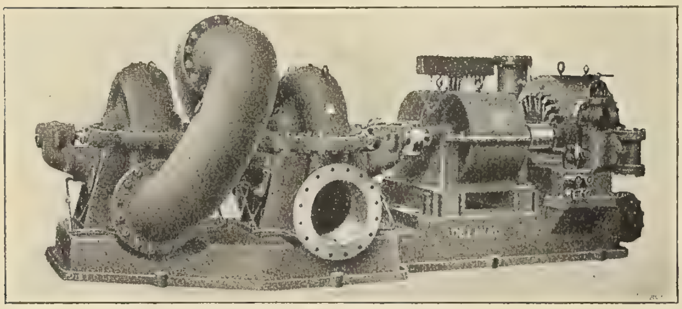


FIG. 3.—DE LAVAL TURBINE CENTRIFUGAL PUMPING SET

which is hard and tough, and has a maximum resistance to erosion and corrosion. The end of each bucket has a dovetail tenon, which fits into a groove turned in the periphery of the steel wheel disk. The wheels are keyed to the shaft, which is made in one piece.

The axial clearance between the stationary and rotating buckets is in general about .06 inch, which is ample to insure operation without friction between the revolving and stationary parts. The radial clearance may, however, be almost anything, and is usually made 1 inch or more, so as to obviate any trouble that may be caused by water accumulating in the casing. In the smaller sizes the bearings are lubricated by means of oil rings. In the larger sizes the oiling system consists of an oil pump, actuated by a worm-gear driven from the main shaft. The pressure in the system is about 10 pounds per square inch, and the oil, after having completed the circuit through the bearings, is returned to a reservoir connected to the pump suction, and is used over and over again.

In the smaller sizes a centrifugal governor is mounted on the end of the main shaft, and operates a balanced poppet valve controlling the steam admission.

In the larger sizes the centrifugal governor is driven by a secondary shaft, and controls the operation of a series of steam admission valves, which through suitable mechanism are operated from the main shaft of the turbine.

This system is practically the same as is used on large power plant turbines made by the General Electric Company. Beside the governor there is an emergency stop valve to prevent undue acceleration in case of a sudden release of the load.

In comparison with engine-driven generating sets the turbo-generators are slightly lighter in weight and take up less room both in height and width, but are longer. They have also a somewhat higher water rate.

A small size turbine of the Curtis type is now being made for driving forced draft blowers by the Fore River Shipbuilding Company. This turbine consists of one 24-inch wheel with five rows of movable buckets and four intermediary ones. It is quite compact, and is being built for use on the new torpedo boat destroyer *Henley*. It is connected direct to the fan impeller, and runs at about 1,400 revolutions per minute.

Parsons Turbine

This type of turbine being inherently unsuitable for small power units has not as yet become of general utility for auxiliary purposes on board ship. As has been already mentioned in this article the generating sets of the Cunard steamers *Lusitania* and *Mauretania* are operated by Parsons turbines. Each one of said turbines is about 525 horsepower and runs at 1,200 revolutions per minute. Their general design is in most of the details similar to turbines built for and operating plants for stationary purposes. But as it is not possible on board ship to obtain the same substantial foundation as on land, a feature of special interest appears in the fastening down of the turbines. To minimize as much as possible the sound which otherwise may be transmitted throughout the ship through the steel decks a rubber insulation is placed directly under the turbine bedplate, a heavy wood filling being placed between the rubber and the deck. Rubber washers, together with rubber bushings in the holes of the bedplate for the holding-down bolts, are everywhere placed in position.

On economy tests performed with these turbines the water consumption at half load was on an average of 61 pounds per kilowatt-hour; at three-quarters load the consumption was 52.5 pounds, and at full load 47 pounds on an average, the back pressure in each case being about 5 pounds, while the steam pressure was 160 pounds gage. The turbines were designed to give full load when exhausting into a back pressure of 10 pounds.

De Laval Turbine

The De Laval type, together with Parsons, constitutes the pioneer types of turbines. It was introduced here as early as 1896, and is being manufactured in units to meet any commercial demand by the De Laval Steam Turbine Company, Trenton, N. J.

De Laval steam turbines are classified under four types:

Class A. In which the steam is expanded completely in one set of nozzles. The velocity of the jet, attained by expansion of the steam in the nozzles, impinges against a single row of buckets, which are attached to a single wheel. As a result of the very high velocity of the steam jets issuing from the nozzles the buckets must also have a very high speed, which is equivalent to a high number of revolutions. In order to make the speed of the driven machine, such as dynamo or pump, come within the practical limits allowed for such machines, a helical pinion and double gear is introduced as a means of speed reduction.

Class B. Is in every respect the same as Class A, with the exception that no gearing is used. This makes an extremely simple and fairly efficient prime mover, which is used in connection with machines that may be run at a very high speed of revolution. Such machines are centrifugal air compressors, small alternators, blowers and certain pumps.

Class C. The steam in this type is expanded in the same manner as in the two types previously mentioned, but instead of one row of moving buckets there are two rows mounted upon a single wheel, with one row of stationary guide vanes between. A modification of this type, Class D, is one in which the steam is expanded in successive sets of nozzles with a corresponding number of pressure stages, each containing revolving discs, with the buckets, in single or double rows, attached. The driver-machine may be directly connected or driven by means of a gear, according to speed requirements.

The De Laval type "C" turbine, as adapted for driving

centrifugal boiler feed and ballast pumps, dynamos and fans and blowers on shipboard, will be more fully discussed in a future issue.

In the construction and design of the De Laval type of turbine we note the following essential parts:

The nozzle is a conically shaped tube, designed both for high-pressure condensing service and low-pressure condensing or high-pressure non-condensing service. Each turbine is fitted with several nozzles, which can be independently operated by individual closing valves, and their number in service at one time may be regulated according to the load.

The buckets are drop-forged, with surfaces coming in contact with the steam, smooth finished with sharp edges and with the proper thickness. Lugs are found upon the outer ends of each bucket, touching the bucket in front to form a continuous band over the ends. The shank is finished with a bulb, which fits in radial slots milled in the edge of the turbine wheel. The buckets are assembled in the wheel when heated, and are tightly held by contraction upon cooling.

The wheel is made of forged steel, and is so designed as to be of uniform strength. A groove is turned just beneath the point of attachment of the buckets, forming a section of least strength, and in case of excessive speed will break the rim at this point, whereby the buckets will be thrown off before other damage is done.

The shaft is flexible and of suitable diameters. With a flexible shaft suitably proportioned the wheel, when a certain speed is reached, rotates about its true mass-axis instead of its geometrical center, and thus obviates vibration.

The bearings are three in number, the first of which is just outside the wheel case, held in a bracket and has a spherical seat. The other two are close to the pinion, one on each side. They are made of bronze with special babbit, having lubricating grooves.

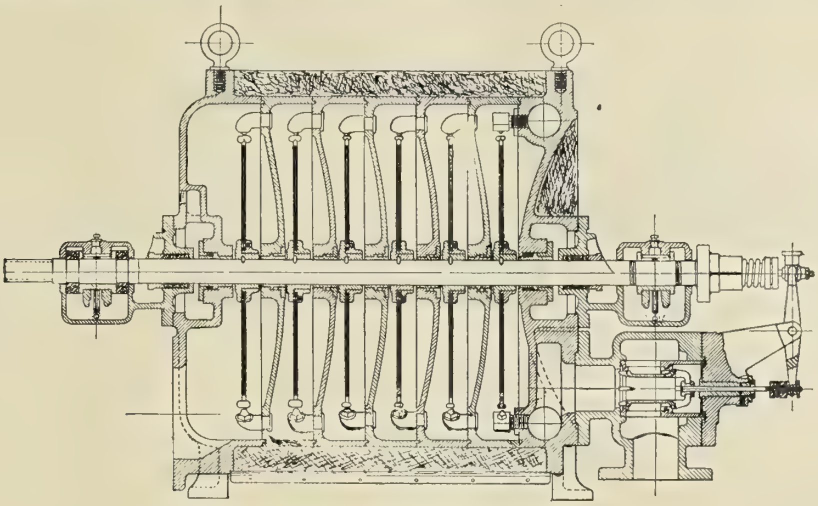


FIG. 4.—SECTIONAL VIEW OF KERR TURBINE

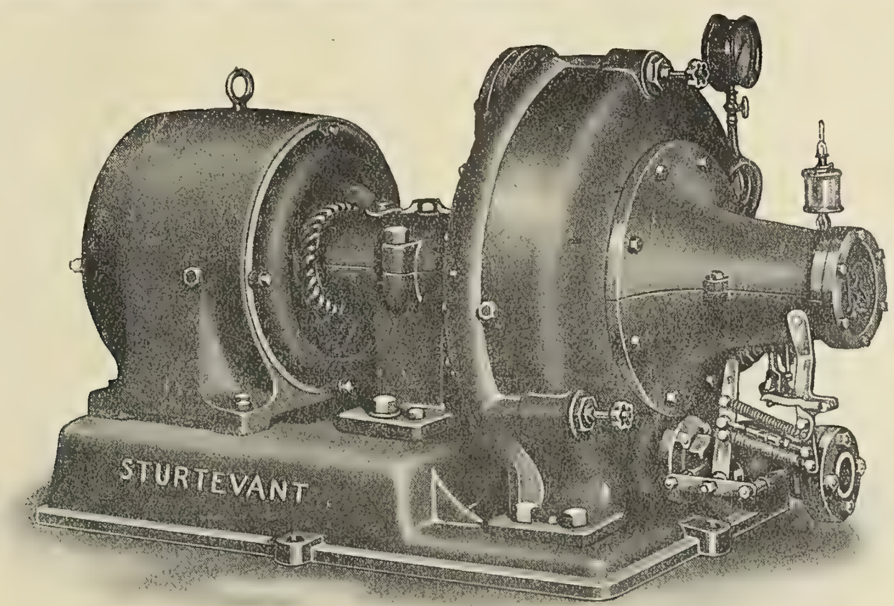


FIG. 5.—STURTEVANT TURBINE-DRIVEN LIGHTING SET

The packing bushings are formed of two small sleeves made of babbit and lined with graphite, which forms a film between the shaft and the bushing that effectually prevents leakage. It is very important in all condensing turbines to prevent air leaking into the wheel and thus insure a good vacuum. No lubrication is required in a graphite bushing.

The gears have for their purpose to reduce the speed of the turbine shaft to a speed suitable to the driving shaft. They

are of the herring bone or helical type, and are machine cut of a fine pitch, so that a large number of teeth may be in contact at one time. The pinion is made of high-grade steel, while the drum of the gear is made of cast iron with a seamless ring forced on.

It may be incidentally mentioned that the gears now used in the propulsion of ships in connection with multi-stage turbines are in all essential respects identical with those used in the De Laval turbine.

The governing mechanism is of a simple and substantial design, and consists of two weights hinged on knife edges,

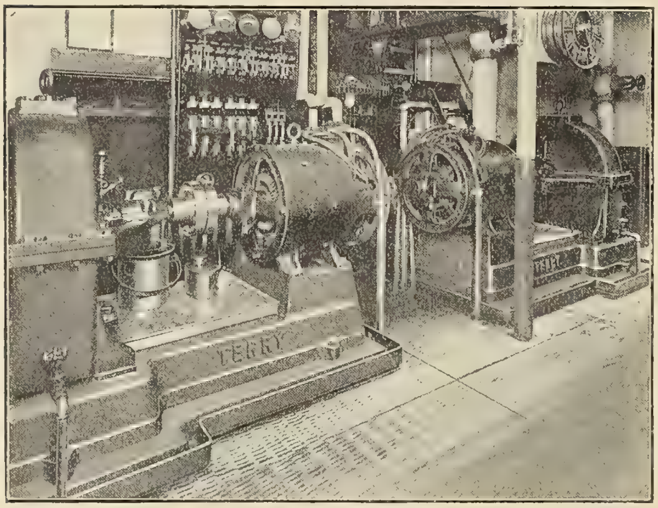


FIG. 6.—30-KILOWATT, 120-VOLT TERRY TURBO-GENERATING SETS IN THE ENGINE ROOM OF THE CITY OF BALTIMORE

which weights, when subjected to the centrifugal force, move outward, and by means of a spring and bell crank operate the throttle valve, through which steam is admitted to the steam chest of the turbine.

Kerr Turbine

This type of turbine, although of a much more recent design and manufacture than any of those previously referred

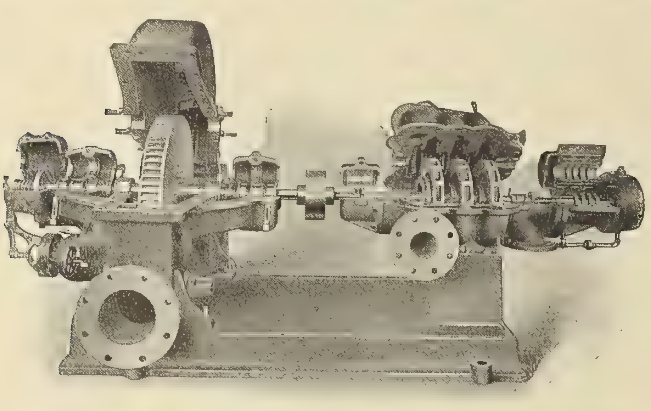


FIG. 7.—THREE-STAGE, 400-GALLON BOILER FEED PUMP DRIVEN BY TERRY TURBINE ON BOARD THE S.S. SIERRA

to, has found an extensive field of application for various installations.

It is of the pure impulse type, and belongs to the class commonly termed "multi-stage turbines," and is made in all sizes from 5 to 600 horsepower. It is manufactured by the Kerr Turbine Company, Wellsville, N. Y., and is being built with from two to eight stages, each stage having its own set of nozzles and disks. As in all impulse turbines its operation rests in the fact of steam attaining a high velocity when expanding in suitably-formed nozzles, and in the jet energy being absorbed by buckets attached to revolving disks. Having a number of stages the pressure drop at each stage becomes comparatively small, and the jet velocity, being also determined by the expansion of the nozzles, may be kept down to reasonable figures and the revolutions of the shaft proportionately. The general arrangement of each wheel and action of impulse upon the buckets resemble those in a Pelton water-wheel.

The turbine cylinder is of cast iron, divided by diaphragms into as many stages as may be desired. Each stage contains one rotor wheel, to the periphery of which the buckets are attached. The wheels are made of flange steel and are attached to the shaft.

The nozzles are located around the inner periphery of the cylinder, with orifices pointing towards the face of the buckets. The number and dimensions are determined by consideration of power and speed, and for multi-stage turbines are so proportioned in the various stages that a uniform velocity is obtained throughout. The nozzles, and the holders for the nozzles, are made of cold-rolled steel, the former being screwed into the latter, which are fastened in the diaphragms.

A new construction, known as "Type M," has now been used in a number of Kerr turbines, in which the nozzles and buckets are supplanted by vanes and blades, thus giving a parallel flow. Ten percent better steam consumption with non-condensing and 15 percent with condensing is guaranteed by the manufacturer for the new construction as compared with the old.

The buckets are made of drop-forgings. There is a throttling governor, actuated by centrifugal force, as well as an emergency governor. In generator work, or where very close regulation is desired, a governor of the oil relay type is used.

Besides the regular bearings there is a thrust-bearing to insure a definite position of the wheel with reference to the nozzles. A special type of this turbine is used for driving the forced draft fans on three torpedo boat destroyers of the United States navy. These turbines are direct connected, and under maximum conditions run at about 1,530 revolutions per minute, the fans maintaining then about 3.3 inches of water pressure. Used in this connection the turbine shaft is vertical, and there are seven stages. The total outside diameter does not exceed 24 inches, and the total length from the fan cone is about 48 inches. A step-bearing made of shouldered steel discs hold the rotor in position.

Terry Turbine

The Terry turbine, built by the Terry Steam Turbine Company, of Hartford, Conn., has been in commercial use for five or six years. It is of the pure impulse type, and for non-condensing work has only one expansion stage, the steam being expanded in correctly proportioned jets down to terminal pressure. For condensing work the machines are designed with one, two or three stages, according to operating conditions and speed. The principle of action is essentially that of any other impulse turbine, all the expansion taking place in the stationary nozzles and the heat energy of expansion being converted into kinetic energy. The steam on leaving the nozzles enters one side of the semi-circular buckets, and is reversed through 180 degrees, and enters a stationary member called the "reversing chamber," which is also semi-circular in form, and returns the steam into the same wheel parallel to the original stream. This cycle is repeated as often as necessary to absorb all the velocity energy in the steam. In the case of two or more stage machines partial expansion only takes place in each stage; for instance, in a straight condensing proposition expanding from 150 pounds to 27 inches vacuum the pressure at the outlet of the high-pressure nozzles will be about atmospheric pressure.

In all essential features, such as automatic lubrication of bearings, emergency spring loaded valves, shaft glands, etc., these are, of course, found here as in all other turbines. This company, however, build practically all of their governors directly mounted on the turbine shaft and run at turbine speed. The cases in all their machines are divided along the center line of the shaft.

The Terry turbine has been used quite extensively for the driving of forced draft sets on torpedo boat destroyers. A special design is employed for this work, as the turbines must be vertical. As in the horizontal machines, the case is divided along the center line of the shaft and the cover hinged to allow easy access to the rotating member.

The step bearing employed is ball-bearing type, placed at the lower end of the shaft, and a gear oil pump is fitted for supplying oil to the different bearings.

Sturtevant Turbine

The Sturtevant turbine is of the compound-impulse, single-wheel type, and may be made in sizes of from 3 horsepower up to 300 horsepower. So far as known only turbines of sizes suitable for driving forced-draft fans have up to the present been built for ship installations. Thus it is intended to replace the reciprocating engine blowers on the United States ships *Smith* and *Lamson* with turbo-blowers of this type.

The Elektra Turbine

Like all of the turbines described, and, in fact, nearly all small-power turbines, this is also of the impulse type. The steam enters a passage surrounding the casing and communicates with a number of expanding nozzles. The divergence of the nozzles is such as to give minimum pressure fall, and therefore velocity. With the several nozzles or return chambers through which the steam flows upon its successive course through the wheel, nearly all of the velocity and consequently the energy is abstracted from the steam.

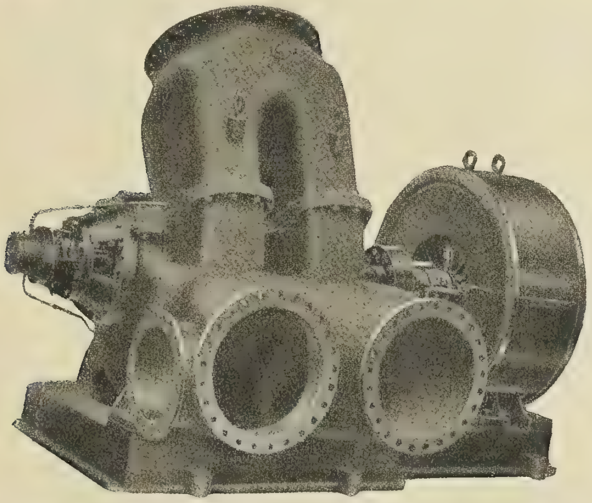


FIG. 8.—CENTRIFUGAL CIRCULATING PUMPING SET DRIVEN BY TERRY TURBINES FOR THE U. S. BATTLESHIP ARKANSAS

Installations

The following contains the essential requirements of the specifications pertaining to turbines when driving electric generating sets and forced-draft blowers for installations in naval vessels:

Turbo-Generators.—The turbines must be perfectly balanced and of high efficiency and economy. They must be provided with an approved oiling arrangement and have automatic regulation for speed governing. Their operation must be noiseless, without undue heating at maximum load, and must be able to stand any sudden change of load without injury to any of their parts.

They must be capable of running continuously at full load with a vacuum, or when exhausting against 5 pounds back pressure. Also to operate satisfactorily at pressures 20 percent above or below the normal of 200 pounds pressure. When, however, running below and against 5 pounds of back pressure only 90 percent of full load need be developed.

Turbo-Blowers.—Having reference to torpedo boat destroyers, the motive power for forced-draft blowers shall be

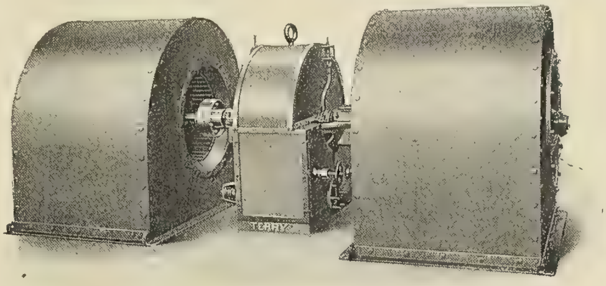


FIG. 9.—MERCHANT SERVICE TYPE OF MARINE FORCED-DRAFT TERRY TURBINE-DRIVEN UNIT. CAPACITY, 25,000 CUBIC FEET PER MINUTE

steam turbines. The speed of revolutions should be about 1,400 per minute at full speed and power, and must be designed to develop the rated output when exhausting against 10 pounds pressure.

A governor must be placed in the steam connection, and be arranged to operate a quick-closing valve to shut off steam in case of undue overspeed. The working parts must be enclosed and proof against dust, yet readily accessible for overhauling. Automatic oiling arrangements must be furnished all bearings, and means must be provided for the attachment of portable revolution counters. It is further stipulated that suitable gear must be arranged for operating the turbine, both from the compartment in which placed and the deck immediately above.

Actual Installations.—All of the types of turbines previously described are installed for auxiliary purposes for one purpose or other in different classes of ships. Thus we find the De Laval turbine used for driving forced-draft blowers in several large steamers belonging to the French trans-continental lines, and also for distiller circulating pumps.

Previous to this time turbo-generating sets had not been tried in the navy, but were then beginning to be installed on a large scale. In the United States ship *New Hampshire*, contracted for in 1904 and delivered in 1908, the forward dynamo room was fitted with a complete turbo-electric outfit, consisting of two direct-current generating sets, driven by horizontal Curtis three-stage, direct-connected turbines, with, respectively, three and two rotating rows of vanes in the first, second and third stage, the revolutions being about 1,700 per minute.

This installation seemed the connecting link in the stage of transition between engine and turbine drives. Practically every ship since then has been fitted with turbine drives for electric power generation aboard naval vessels.

The Curtis type turbine, as made by the General Electric Company, of Schenectady, N. Y., has been fitted to the following naval vessels:

New Hampshire, two 100-kilowatt generating sets.
South Carolina, four 200-kilowatt generating sets.
North Dakota, four 300-kilowatt generating sets.
Delaware, four 300-kilowatt generating sets.
Florida, four 300-kilowatt generating sets.
Utah, four 300-kilowatt generating sets.
Arkansas, four 300-kilowatt generating sets.
Wyoming, four 300-kilowatt generating sets.

Cincinnati, two 30-kilowatt sets.
Raleigh, two 30-kilowatt sets.
Iowa, three 100-kilowatt sets.
Michigan, four 200-kilowatt sets.

All of foregoing 300-kilowatt machines have two stages, three rows of moving buckets with revolutions of 1,500 per minute.

Among ships fitted with the same type of turbine, but of

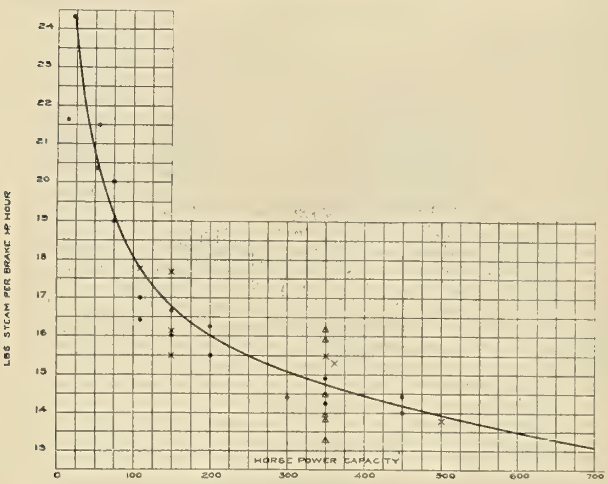


FIG. 10.—DIAGRAM SHOWING VARIATION OF STEAM CONSUMPTION OF DE LAVAL TURBINES, WITH CAPACITY

only 5-kilowatt capacity, being of the single-stage, four-nozzle horizontal type, direct connected, 5,000 revolutions per minute, we find something like twenty-five torpedo boat destroyers. In merchant vessels the installation of two 35-kilowatt, 3,500 revolutions per minute sets on the steamship *Alabama* for the Goodrich Transit Company, Chicago, Ill., may be cited as an example. Curtis turbines for lighting sets are installed in sizes of from one 75-kilowatt set to three 35-kilowatt sets on seven United States transports; the United Fruit Company has twelve steamers with four 35-kilowatt sets each; the Merchants & Miners' Transportation Company three steamers with one 35-kilowatt set, and two Standard Oil steamers and one collier have installed 10-kilowatt sets.

Terry turbines are used extensively in marine service. On

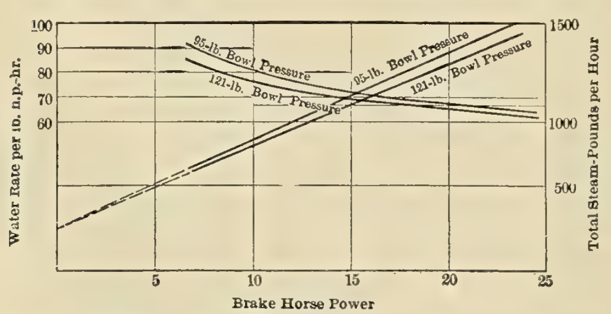


FIG. 11.—STEAM CONSUMPTION CURVES, STURTEVANT TURBINE, 20-INCH WHEEL, SINGLE-STAGE, NON-CONDENSING, 2,400 R. P. M.

merchant craft they are largely used for boiler-feed service, ballast pumps, lighting and forced draft.

On United States Government vessels alone 140 Terry turbines are being used or installed as follows:

Generators—On battleships, destroyers and other boats,, twenty-eight 5 to 100-kilowatt sets.

Blowers—On destroyers, 104 forced draft sets; other boats, four forced draft sets.

Pumps—On battleships and other boats, four 17 to 400-horsepower pump sets.

Terry turbines are also being used in the British and Chinese navies.

The latest application of the Terry turbine is for driving condenser circulating pumps on the *Arkansas*, illustration of which is given.

Kerr turbines are used in a similar way for operating the blowers on United States ships *Perkins*, *Sterrett* and *Walke*.

A type of the Elektra turbine, which is extensively used for stationary purposes in European practice, has had a practical test in this country as a ship auxiliary in connection with the Leblanc air pump installed on the United States collier

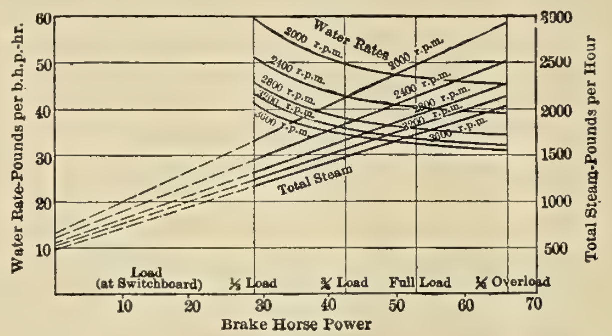


FIG. 12.—STEAM CONSUMPTION CURVES, 200-H.P. CURTIS TURBINE, THREE-STAGE, 36-INCH WHEEL, NO SUPERHEAT, NON-CONDENSING

Neptune, built by the Maryland Steel Company at their marine plant in Sparrows Point, Md. The air pumps were built by the Westinghouse Machine Company, Pittsburg, Pa., and when tested in the shops ran about 2,200 revolutions per minute, developing about 50 horsepower on an average steam consumption of 50 pounds per horsepower, exhausting at 10 pounds pressure.

What may be considered a disadvantage with turbine installations when used for electric drives on board ship is the increased vacuum necessary in order to obtain satisfactory steam economy. The much augmented steam volume with a 27-inch vacuum common with turbine drives over 16 or 20 inches, as were customary with engines, requires very much larger exhaust pipes. The space occupied by these pipes in the often rather cramped spaces allotted to them in the ship arrangement often leads to difficulties. Moreover, the whole

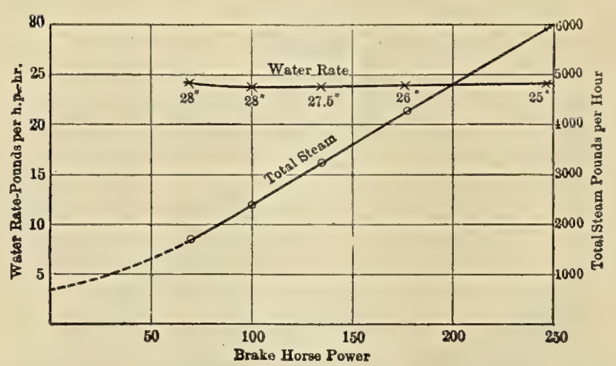


FIG. 13.—STEAM CONSUMPTION CURVES, 24-INCH KERR TURBINE, SIX-STAGE, CONDENSING, VARYING VACUUM, 70 POUNDS PRESSURE GAGE

condensing apparatus must be larger, and as a whole becomes more expensive as well as requires more space. The turbine, together with the generator, are bolted down, and through the bedplate are fastened direct to the steel foundations without any resilient material to deaden sound or to minimize shock.

The Parsons turbine as an auxiliary aboard ship has been previously referred to.

While undoubtedly many installations have been made with various other types of turbines in connection with the furnishing of power for auxiliaries aboard ship, the application, being of comparatively recent origin, precludes in many instances the necessary data for the diffusion of reliable information.

STEAM ECONOMY

Only an approximation to actual steam economy can be given here, as the numerous circumstances inductive of results cannot possibly be accounted for. Two distinct conditions which substantially influence the steam economy must, however, be carefully noted, viz.: running, condensing and running non-condensing, or, in other words, with a vacuum or with atmospheric or higher pressure at the exhaust. Other items which influence the economy in a very material degree are running at designed power, below or above at an overload. Also running at rated number of revolutions, or at speed much below.

The following give some actual test data or guaranteed economies:

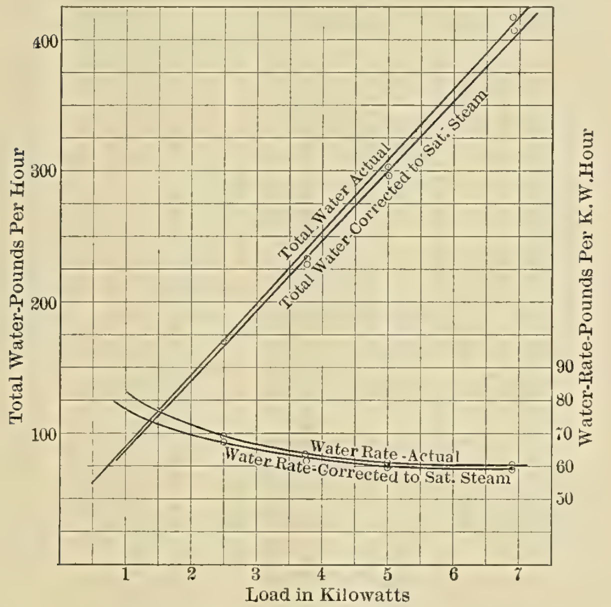


FIG. 14.—TESTS OF 5-K.W. TERRY TURBO-GENERATING SET ON U. S. S. FANNING. STEAM 187 POUNDS, VACUUM 27 INCHES, SPEED 3,820 R.P.M.

TESTS OF 5-K. W. TURBO-GENERATING SET FOR U. S. S. T. B. D. FANNING.

BUILT BY THE TERRY STEAM TURBINE CO., HARTFORD, CONN.

	Guaranteed.	Results of Test.
Date of test	....	8/8, 9, 12/11
Steam pressure	200.	187.6
Quality	1.00	.982
Vacuum, inches	25–28	27.
Speed, R. P. M.	3800.	3820.
33⅓% overload water-rate, steam 186.6, vacuum 26.7, quality .982	....	60.4
33⅓% overload water-rate, corresponding to saturated steam at 200 pounds	78.	58.5
Full load water-rate, steam 187.6, vacuum 26.87, quality .9825	....	60.6
Full load water-rate, corresponding to saturated steam at 200 pounds	62.	58.8
¾ load water rate, steam 187.2, vacuum 27.00, quality .983	....	62.4
¾ load water-rate, corresponding to saturated steam at 200 pounds	71.	60.6
½ load water-rate, steam 187.4, vacuum 27.1, quality .983	....	68.43
½ load water-rate, corresponding to saturated steam at 200 pounds	81.	66.35
Maximum momentary speed variation, load thrown off	....	2.11%
Settled speed variation, normal condition	3.50%	.79%
Maximum jump volts, load thrown off	18.75	5.6
Maximum temperature rise, full load	40.	31.
Maximum temperature rise, 33⅓% overload	60.	41.
Volts variation, compounding test	2.5	2.4
Over-speed trip, in % above normal	10.0	5.94
Commutation after full load	....	No. 1
Commutation after 33⅓% overload	....	No. 1¼

Operation satisfactory with 33⅓% overload and 5 pounds back pressure. All water rates in pounds per K. W. hour. (Normal steam.)

Terry Turbines.—For generators, by test, full-load capacity of generator, 85 kilowatts.

Steam pressure = 150 pounds.
Quality steam = 1.00.
Vacuum = 27 inches.
Revolutions per minute, 2,300.
Water rate, full load per kilowatt-hour, 32 pounds.
Water rate, half load per kilowatt-hour, 43 pounds.
Water rate for forced draft blowers, by test.

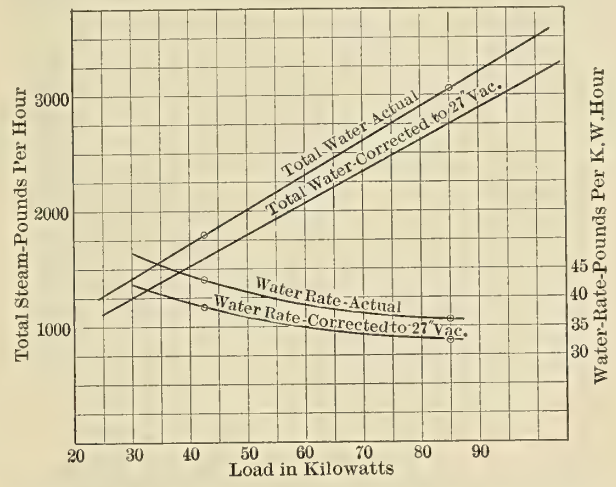


FIG. 15.—TESTS OF 35-K.W. TERRY TURBO-GENERATING SET ON U. S. S. YOSEMITE. STEAM 150 POUNDS, VACUUM 27 INCHES, SPEED 2,240 R.P.M.

Steam pressure, 160 pounds.
Back pressure, 20 pounds absolute.
Revolutions per minute, 1,400.
Brake horsepower, 60.
Water rate per brake-horsepower-hour, 1,400 revolutions, 59 pounds.
Water rate per brake-horsepower-hour, 1,000 revolutions, 77 pounds.

For further information the reader is referred to economy curves shown in Figs. 10-15.

In conclusion it may be added that the small-type turbines, while not as economical under slow speed conditions of operation as the best engines, on the whole are to be preferred for the different advantages they offer when used for auxiliary purposes.

Boiler Manufacturers' Convention

The twenty-fourth annual convention of the American Boiler Manufacturers' Association, together with its associate members and the Supplymen's Association, will be held in New Orleans, La., March 12, 13, 14 and 15, 1912. Some very important papers will be presented at the meeting, and other important business of interest to all the boiler manufacturers in the United States and Canada and supply houses dealing with the boiler and tank industry will be transacted. An extensive programme of entertainment has been arranged, and a large attendance of boiler manufacturers and supplymen from the United States and Canada is expected. Information relative to rates, hotel accommodations, can be obtained from F. B. Slocum, Continental Iron Works, Brooklyn, N. Y.

Navy League Annual Convention

The seventh annual convention and dinner of the Navy League of the United States will be held in Washington, D. C., February 22 to 24. The convention will open at 10 A. M., February 22, at the New Willard Hotel, where the dinner will also take place the same evening.

The World's Progress in Shipbuilding in 1911

From information compiled by the *Glasgow Herald* the total tonnage of vessels, including warships, built in the world in 1911 was 50.9 percent greater than that built in 1910. In the United Kingdom there was an increase of 55.3 percent, in Germany 84.6 percent, in France 84.9 percent, in Holland 44 percent, in Italy 141 percent, and in Japan 40.3 percent. The greatest increase occurred in Russia, although the total tonnage was comparatively small. This remarkable increase simply indicates the beginning of a new warship building programme, which heretofore the shipbuilding industry in that country has lacked. In only one of the leading shipbuilding countries was there a decrease over the past year, and that was in the United States, where the total tonnage built in 1911 was 23.6 percent less than that built in 1910. This decrease was due entirely to the lack of work in the large shipyards on the Great Lakes, where over-production in the preceding year reduced the demand for new tonnage in 1911.

The figures are as follows:

	1911.		1910.		Increased Tonnage Built
	Tons.	I. H. P.	Tons.	I. H. P.	Percent.
England	1,221,948	1,139,527	752,136	861,034	62.5
Scotland	671,624	837,668	420,250	624,268	60.0
Ireland	186,825	150,116	167,102	137,730	11.8
United Kingdom totals.	2,080,397	2,127,311	1,339,488	1,623,032	55.3
Colonial	29,249	12,875	24,077	10,237	21.5
Germany	401,881	666,785	217,748	306,087	84.6
United States	268,561	257,825	351,369	304,689	—23.6
France	184,411	324,205	99,796	165,630	84.9
Holland	178,618	101,730	124,115	86,019	44.0
Russia	94,905	169,215	1,854	160	5000.0
Italy	86,814	148,150	36,075	62,600	141.0
Japan	84,462	164,375	60,192	96,633	40.3
Austria-Hungary	68,390	48,485	32,121	29,706	113.0
Norway	38,222	41,004	32,998	30,890	15.9
Denmark	18,961	18,040	11,922	10,753	59.0
Belgium	12,489	1,798	15,302	26,965	—18.4
Sweden	9,734	16,931	9,733	21,940	......
Spain	6,760	10,800	3,234	......	109.0
China	4,222	3,920	5,211	3,205	—19.0
Greece	......	......	20	180	......
Grand total	3,568,076	4,103,449	2,365,255	2,778,725	50.9

A comparison of the work done in the principal shipbuilding centers of the world is shown by the following table:

PRINCIPAL DISTRICTS.

	Vessels.	Tons.	I. H. P.
The Clyde	413	630,583	789,929
The Tyne	125	417,175	421,060
Germany	330	401,881	666,785
The Wear	86	286,834	193,343
Tees and Hartlepools	134	279,245	160,640
United States	160	268,561	257,825

As has been the case in the last two years, the largest tonnage launched by any one concern during the year was by Harland & Wolff, at Belfast. Nearly as large a tonnage was launched by Swan, Hunter & Wigham Richardson, and the other leading shipbuilders were all British concerns.

LEADING SHIPBUILDERS.

	Vessels.	Tons.
Harland & Wolff	10	118,209
Swan, Hunter and Wigham Richardson	24	109,861
Wm. Doxford and Sons	17	80,400
Sir W. G. Armstrong, Whitworth & Co	13	74,124
Wm. Gray & Co.	18	73,588
Russell & Co	14	72,230

The largest ship launched during the year was the White Star liner *Titanic,* sistership to the *Olympic,* at Belfast. As in the case with tonnage, the Harland & Wolff and the Swan Hunter & Wigham Richardson Companies stand at the head of the list for having launched the largest ships during the year, the former with the *Titanic* and the latter with the Cunarder *Laconia.* The *Laconia,* however, is a much smaller ship, being of only 18,150 gross tons as compared with the *Titanic's* 45,000. The next largest vessel was also launched by Harland & Wolff. It was the Royal Mail liner *Arlanza* of 15,000 tons. Other large ships launched in 1911 included the *Cap Finisterre,* 14,500 tons, by Blohm & Voss at Hamburg, Germany; the *Shinyo Maru,* 13,377 tons, by the Mitsu Bishi Company at Nagasaki, Japan, and the *Orama,* 12,927 tons, by John Brown & Company, at Clydebank. The *Titanic* and *Orama* have combination reciprocating and turbine machinery, the *Laconia* and *Cap Finisterre* reciprocating engines and the others Parsons turbines.

In the United States, which was the only large shipbuilding center in the world where there was a marked decrease in the tonnage built in 1911, somewhat unusual conditions existed. In recent years the greatest amount of tonnage built in the United States has come from the shipbuilding districts on the Great Lakes. The largest company there is the American Shipbuilding Company, which comprises seven yards, and which has usually figured as one of the leading shipbuilders in the world in the point of tonnage produced.

This year, however, this firm does not appear in the list of leading shipbuilders given above, and the depression there was evident in most of the shipbuilding yards on the Great Lakes. This decrease of tonnage built on the Great Lakes was responsible for the decrease in the total tonnage built in the United States during 1911, and was caused principally by the over-production of bulk freighters in the preceding year. From present indications, however, these yards will soon resume their former rate of production, as the demand for more bulk freighters will soon be felt. During the last year several freight steamers were built on the Great Lakes for ocean service, and other similar orders are now in hand. The production on the Lakes in 1911 included only five large bulk freighters, as compared with records of from twenty to forty of such vessels each year in the past five years. The number of other vessels, including passenger steamships and packet freighters, amounting to a comparatively small part of the total tonnage, was about equal to the amount of work done in previous years.

As the conditions on the Great Lakes have only a purely local effect depending upon the maritime commerce on inland waters, the records of the coastwise shipyards must be looked to for an indication of the position of the United States in relation to the world's shipping. Here we find every indication of an increase in tonnage under construction, which corresponds favorably with the rate of increase in other important shipbuilding countries. The total tonnage built in the past year was not large, but at the present time most of the larger shipyards on the Atlantic Coast are rapidly booking orders, which will fill these establishments to full capacity for several years to come. The impetus to shipbuilding comes largely from the new conditions which will result from the opening of the Panama Canal.

The largest single order which is now before the shipbuilders of the Atlantic Coast is the call for bids for four ships by the Pacific Mail Steamship Company, each of which is to be of 15,000 gross tons, 660 feet long between perpendiculars, 75 feet beam, 50 feet depth, with a load draft of 30 feet. The ships are to have a speed of 16 to 18 knots.

Another large order was recently placed by the American-Hawaiian Steamship Company with the Maryland Steel Company at Sparrows Point, Md., for five 10,000-ton passenger and freight steamers.

At the New York Shipbuilding Company, Camden, N. J., naval work predominates at the present time. There are under construction the 26,000-ton battleship *Arkansas* and the 27,000-ton battleship *Moreno*; a Chinese cruiser and two United States destroyers. As far as merchant work is concerned, three large oil tank steamships have been ordered by the Standard Oil Company, and the hull for the largest river steamer in the world, the *Washington Irving*, which will be in service on the Hudson River next summer, is under construction. Besides the five large freight steamships for the American-Hawaiian Steamship Company, there are building at the Maryland Steel Company's plant two 10,000-ton colliers for the United States navy. Some small harbor and river boats have also been delivered during the year.

As is usually the case, the Government work is fairly well distributed through the Atlantic Coast yards. At the Newport News Shipbuilding & Dry-Dock Company, Newport News, Va., the battleship *Texas*, one submarine, one destroyer, two colliers and two revenue cutters are now under construction. They also have a freight steamship of 3,500 gross tons for the Bull Steamship Company, New York, and a 6,000-ton passenger and freight steamer for the Clyde Steamship Company. At the William Cramp & Sons Ship and Engine Building Company, Philadelphia, most of the construction is naval work, including the battleship *Wyoming*, five destroyers, a submarine and two Cuban naval vessels. Similarly, at the Fore River Shipbuilding Company, Quincy, Mass., besides a large suction dredge built for the United States War Department, and some small fishing steamers, the work in hand is naval work, including the Argentine battleship *Rivadavia*, two United States destroyers and six submarines. Four destroyers are also building at the Bath Iron Works, Bath, Me.

On the Pacific Coast the tonnage, though small, is beginning to increase, indicating that the next year will be a satisfactory one. Twelve vessels, including four submarines for the United States, two submarines for the Chilean Government, and five steel whaling ships and one passenger steamer are building at the Seattle Construction & Dry-Dock Company, Seattle.

At the Union Iron Works, San Francisco, Cal., several submarines and coasting steamers are under construction, and, as in all of the Pacific Coast yards, such as the Hall Brothers, Marine Railway & Shipbuilding Company, Eagle Harbor, and the Craig Shipbuilding Company, Long Beach, Cal., a large amount of repair work has been done.

DISTRIBUTION OF SHIPBUILDING IN UNITED KINGDOM.

	1911.			1910.		
	Vessels.	Tons.	I. H. P.	Vessels.	Tons.	I. H. P.
The Clyde	413	630,583	789,929	358	392,392	593,840
The Forth	31	11,319	9,355	17	9,385	5,935
The Tay	31	17,303	14,770	15	5,982	7,800
Dee and Moray Firth	82	12,419	23,614	60	12,491	16,693
The Tyne	125	417,175	421,060	81	236,688	272,991
The Wear	86	286,834	193,343	58	173,673	124,205
Tees and Hartlepools	134	279,245	160,640	86	187,305	115,975
Mersey to Solway	128	84,085	144,449	95	41,835	144,804
The Humber	117	44,966	55,770	77	28,033	42,710
The Thames	167	38,504	72,751	143	11,532	30,680
English Channel	97	8,829	90,974	93	11,373	128,969
Bristol Channel	36	3,050	540	56	9,176	700
Royal Dockyards	7	59,260	......	4	52,521	......
Ireland	24	186,825	150,116	......	167,102	137,730

All of the shipbuilding districts in the United Kingdom shared in the substantial increase in the production of tonnage for the year 1911. As usual, the Clyde shipyards surpassed the other districts in the matter of total tonnage, and the output there was all the more remarkable on account of the low records made in the last three years. The new records were made not by the construction of large ships, but by a vast increase in the construction of vessels of moderate size, principally trading steamers of from 2,000 to 9,000 tons. There was, of course, a great variety of work, including almost every type of ocean, harbor and river steamer. Some unusual ships were built, the most notable of which was the 5,000-ton oil-engined vessel *Jutlandia*.

The increase in tonnage built on the Clyde was also accompanied by a marked increase in marine engineering work. Much of this was the manufacture of turbines. At the present time the prospects on the Clyde are very good. The largest ship under way is the *Aquitania* at Clydebank. Four large steamers for the Canadian service, a New Zealand liner, and 50,000 tons of P. & O. steamers are also on the stocks in various yards. Besides the oil-engined vessel already mentioned, the Clyde Shipbuilding Company of Port Glasgow is building another oil-engined ship for service on the American lakes.

In the English shipyards the bulk of the increase was on the northeast coast, where the activity has been abnormal. The greatest amount of work was done in the Tyne district. The work in the Tees and Hartlepools district kept pace with the other shipbuilding centers, most of the product being moderate-sized screw steamers. The Thames district, as might be expected, has suffered from the lack of naval work, and it does not seem probable that this will be regained. A large amount of naval work was done in the Mersey district, including one battle cruiser, one protected cruiser, three torpedo boat destroyers and two transports for the British Government, four destroyers for the Argentine Government and one cruiser for the Chinese Government.

The two leading English Channel firms, Messrs. Thornycroft, of Southampton, and Messrs. White, of Cowes, have during the year completed and now have under construction a large number of torpedo boat destroyers for the Britsh Government. The other work turned out by the English Channel yards has been confined largely to small power boats, such as launches, pinnaces and yachts.

In the leading Irish shipyard, where such wonderful records have been made, there is a large tonnage on hand. The largest vessel now building outside of the *Titanic* is a Holland-America liner of 32,500 tons, and a White Star vessel of 18,000 tons for the Australian service. Three moderate-sized steamships for the Royal Mail Steamship Company, and one each for the Bibby and Elder Dempster lines, are in hand. The total output of the British Royal Naval establishments for the year consisted of two battleships of 23,300 tons each, two scout cruisers of 3,380 tons each; a protected cruiser and two submarines, making an average year of work for the dockyards.

In foreign countries, Germany stands in first place for the amount of tonnage produced during the year, and also the size of ships is rapidly increasing. Notwithstanding the big output of the last year, a large amount of both the naval and merchant marine work is still on hand. The largest vessel is, of course, the Hamburg-American liner *Imperator*, of 52,000 gross tons, building by the Vulcan Company of Stettin. A number of interesting oil-engined ships, ranging from 8,000 to 15,000 tons carrying capacity, are also under construction at Kiel for the German-American Petroleum Company.

France has had an unusual year of prosperity in shipbuilding. The naval work included two battleships, nine destroyers, three gunboats, two submarines and a destroyer dock. The steamship *Rochambeau*, previously described in our columns, was the largest vessel built during the year, but this is being followed by another at La Ciotat for the mail service of the Messageries Maritime to the Far East, and the twin-screw steamer *Valdivia*, built at Port de Bouc, for the Cie. Transport Maritime of Marseilles.

A Slipping Clutch for Diesel Marine Engine Installations

BY J. RENDELL WILSON

As indicated in our January issue there were Diesel-engined vessels in service in Russia long before the reversible marine oil engine was perfected, and the success of these ships was in no small way due to the Koreiwo pneumatic slipping clutch, the use of which has been so satisfactory in that country that it has been retained with 1,000 horsepower craft launched in 1911, despite the fact that these later vessels have reversible oil engines installed. In the first two boats owned by Messrs. Nobel Bros., of St. Petersburg, the Del Proposto system of electric transmission was adopted; but evidently this gear absorbed too much power, as practically all the remainder of their craft were fitted with Koreiwo clutches, as also were some ships engined for other firms by the Kolomnaer Company.

Delo, a 4,000-ton tank-ship, driven by two 500-horsepower Diesel engines, and illustrated in our January issue, has two of these clutches to each engine, one at the forward end and one at aft. Fig. 1 shows the arrangement of the starboard engine, the port engine being, of course, a duplicate. (*A*) is the four-cylinder engine (*B*) the after clutch, and (*C*) the forward clutch. When the order to reverse ship is given the clutch (*B*), which is connected to the propeller shaft, is thrown out of engagement, and the forward clutch (*C*) is automatically thrown into action. The drive is then transmitted to the shaft (*F*), which runs alongside the engine by chain drive (*M*) from the extension pinion (*E*), thence through the gear wheels (*S*). This, of course, gives a reverse action to the propeller shaft. But the Koreiwo clutch has another important feature, namely, that with its use only a fraction of the engine power need be transmitted; in fact, anything from zero to full power. This is most useful in crowded river or harbor traffic, and gives vessels so equipped all the maneuvering qualities of a reciprocating-engined steamship.

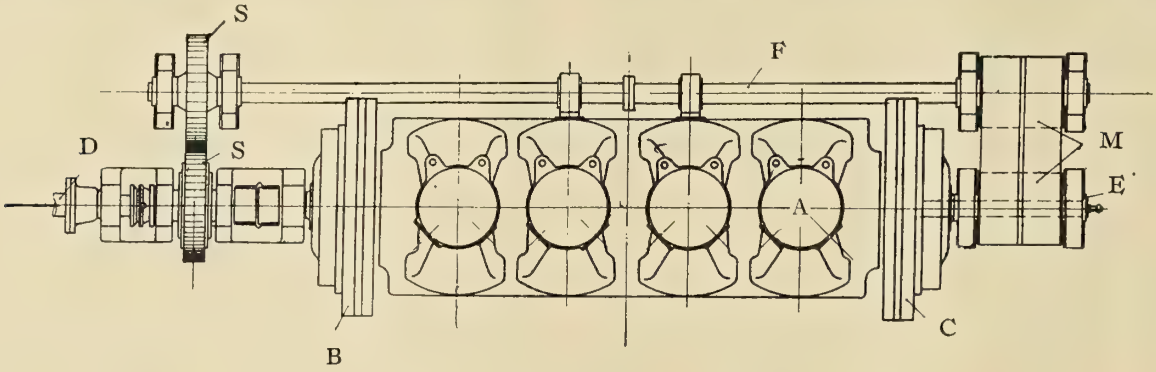


FIG. 1

Regarding the construction of the Koreiwo clutch, the design is certainly very ingenious and well thought out, and the following description should be of special interest to shipowners and marine engineers, as we do not know of a single instance outside of Russia where it has been installed in a ship. In that country, as before stated, it is widely in use, especially in connection with the big Diesel-driven paddle-boats.

Turning to Fig. 2 the fly-wheel (*C*) and the casing (*D*) are the section of the clutch keyed to the engine crankshaft, while contained in the casing (*D*) is the other half of the clutch, which is carried on the boss (*E*), the latter being keyed to the propeller shaft. To the inner plates of both faces annular copper diaphragms (*H*) are fitted, and under these spaces, which connected to the ship's compressed air supply, are formed, the connections being through the channels P^1 and *P* in the tail-shaft and plate, respectively. Similar plates, but thicker, are fitted over the diaphragms, and on the plate are fixed solid rings, which carry lignum vitæ (one of the hardest of woods known) strips (*L*).

Copper rings (*F*) are fitted to the interior faces of the fly-wheel (*C*) and casing (*D*), while radial channels are cut into the faces of the lignum vitæ strips, permitting the flow of water from the pipe (*N*) into the casing (*D*). This water is thrown by centrifugal force into the inner periphery of the casing, whence it passes through the channels (*S*) to the rim of the fly-wheel, and is then forced by inertia through the off-take (*O*). When there is no pressure under the diaphragms (*H*) lignum vitæ strips do not touch the copper rings, and the clutch is then inoperative. Upon admission of compressed air through the aforementioned inlet channels (P^1) and (*P*), the diaphragms (*H*) and the sheet springs transmit the pressure to the lignum vitæ strips (*L*), which are thus brought into contact with the copper rings (*F*), causing the clutch to immediately grip.

As the gripping power is in accordance with the pneumatic pressure under the diaphragms, it can be regulated by a manometer also, because an almost constant coefficient of friction is maintained by the continued surface lubrication. Thus the gripping power can be varied from nil to the full engine power. It may be argued that the friction surfaces will wear rapidly, but by actual practice this theory has been proved wrong. In the Koreiwo clutches constructed by the Kolomnaer Company the surfaces are of soft copper and lignum vitæ, which when lubricated with water wear exceedingly well. Generally a pressure of about 38 pounds per square inch has to be transmitted, while lignum vitæ has such splendid qualities that it can safely be loaded to 350 pounds per square inch.

For the working of the clutch in actual service let us return to the machinery of *Delo,* as this vessel has been successfully running since 1908, a fact which should make American and British marine engineers kick themselves to make sure that they are awake. Her two 500-horsepower engines develop their rated power at about 200 revolutions per minute, so the pressure in each clutch when she is at full speed (9.3 knots) is 36.7 pounds per square inch, and since the ratio between the surface of the diaphragm and the lignum vitæ strips is

3.5, the pressure between the lignum vitæ and copper friction surfaces cannot exceed 128 pounds per square inch. But at this pressure the drive is practically direct, as there is no slip, and consequently no wear. For maneuvering the ship, the engine, being fairly flexible, is generally brought down in speed to about 130 revolutions per minute, reducing the vessel's speed to about 5½ knots. It is only very rarely that a slower speed than this is required, and then only for short periods, and as the slipping of the clutch is only required for speeds under 5½ knots, it really gets very little wear.

Were the ship traveling at 3 knots the propeller shaft

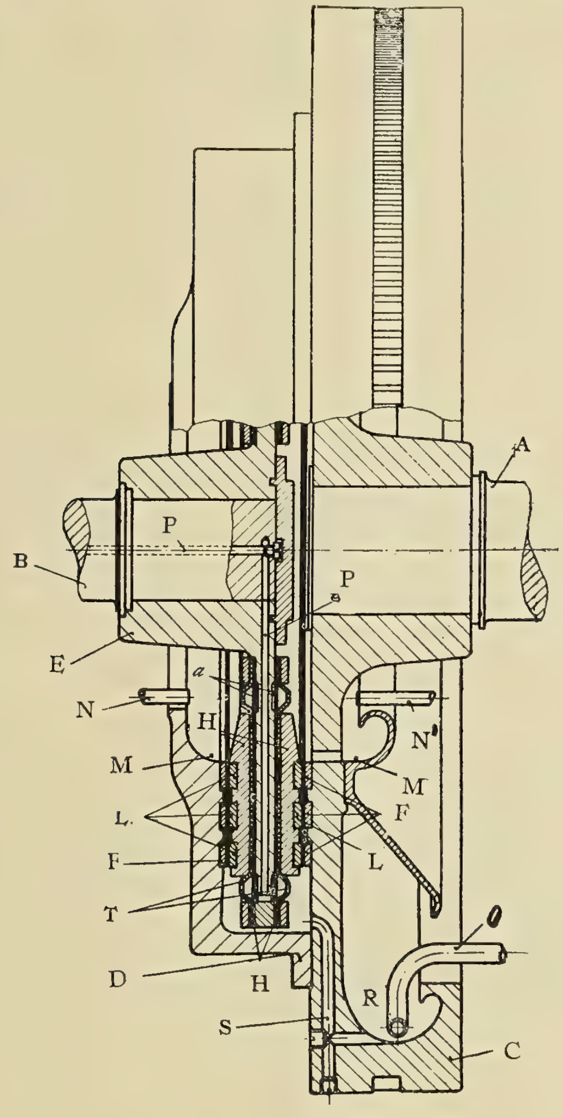


FIG. 2

would be turning at 50 revolutions per minute and the engines at 130 revolutions per minute, while the air pressure in the clutch would be 2.3 pounds per square inch and 8 pounds per square inch between the frictional surfaces. This will show how slight is the wear under working conditions, and should do much to remove the prejudice against slipping clutches held by the majority of marine engineers, as despite all theory the proof of the pudding is the eating thereof. These clutches, but of a slightly different pattern, are also used on the numerous big side-paddle tugs in service on the Volga, which are fitted with Diesel engines ranging from 300 horsepower to 800 horsepower. *Myssl,* the first of these, was built five years ago, and is owned by Messrs. Merkuler Bros., who are the owners of *Delo.*

While on the subject of Russian Diesel ships we take the opportunity to supplement the information given in our January issue. The work of carrying out Diesel installations in ships has been about evenly divided between the Kolomnaer Company and the Maschinenfabrik Ludwig Nobel, of St. Petersburg, who must not be confused with Messrs. Nobel Bros., the great oil firm and owners of Diesel ships. Ludwig Nobel engined the following vessels in Nobel Bros.' fleet: *Wandal* (360 horsepower), *Sarmat* (360 horsepower), *Belemor* (140 horsepower), *Samojed* (280 horsepower), *Robert Nobel* (700 horsepower), *Osjetin* (400 horsepower), *Leegin* (400 horsepower), *Ingusch* (400 horsepower), and *Masur* (200 horsepower). Ludwig Nobel also engined the following Russian Diesel gunboats: *Kars* (1,000 horsepower), *Ardagan* (1,000 horsepower), *Smertsch* (1,000 horsepower), *Graza* (1,000 horsepower), *Schtorm* (1,000 horsepower), and *Schwal* (1,000 horsepower). The last named was placed in service in 1909. She is driven by four 4-cylinder 250-horsepower Diesel motors, a fact which places the Russian navy in the proud position of being the most far-sighted navy in the world. *Kars* and *Ardagan* have two 500-horsepower engines apiece. The firm have also engined a number of Diesel submarines for this navy, and are constructing the Diesel engines for the 1,200-horsepower revenue cruiser launched on Dec. 16 last at Nicolieff. But the most interesting, if not the most important item to record, is the fact that Louis Nobel has perfected the light-weight high-speed marine Diesel engine, and in 1910 installed an 8-cylinder V-type motor developing 150 horsepower at 600 revolutions per minute in his yacht *Intermezzo.*

Twelfth International Navigation Congress

The Twelfth International Congress of Navigation will convene in Philadelphia May 23 next. Its sessions will be opened with a formal address by President Taft, Head Patron of the Congress, followed by a reception to the delegates of foreign nations and distinguished foreign engineers who will attend.

This is the Twelfth International Navigation Congress and the first to be held in America. Previous Congresses have been conducted at intervals of about four years since 1885, in Belgium, Holland, England, Germany, Italy, France and Austria, and the last was held in St. Petersburg in 1908.

The purposes of these Congresses, broadly speaking, are to further the progress of work in the interest of navigation. The Permanent Association which conducts the Congresses now includes thirty-five nations in its membership as well as thousands of the foremost engineers and navigation authorities of the world. Its headquarters are in Brussels, and it is governed by a commission composed of delegates from the various countries holding membership.

The proceedings of the Congress at Philadelphia will be divided into two sections—one on inland waterways and the other on ocean navigation. Some of the important subjects to be discussed are the equipment of ports with mechanical facilities for freight handling, the most economical and profitable dimensions for barge canals, the proper dimensions for ship canals, such as those of Panama, Suez and the Kaiser Wilhelm Canal in Germany; the probable dimensions of ocean steamships of the future (on which depends largely the size of docks and canals planned now); the control and improvement of navigable rivers; the use of concrete for construction seawalls, retaining walls, docks, canal locks, piers, etc., means for docking and repairing vessels, etc. Many of these subjects, particularly those relating to barge canals, river and harbor improvements, port facilities and means for docking and repairing vessels are of vital importance in America at present, and the discussions at this Congress will be of great value.

Report of the Chief of the Bureau of Steam Engineering

The annual report of Rear Admiral H. I. Cone, Chief of the Bureau of Steam Engineering of the United States navy, contains some interesting information regarding the progress which has been made in the development of the machinery for the latest warships. In addition to the usual repairs and renewals to the machinery of the fleet, work of considerable extent and involving large expenditure has been done to the machinery of a number of vessels. The preparation and examination of plans for repairs and alterations to machinery of vessels in commission and those fitting out at navy yards, and for the construction of new machinery and boilers building at navy yards and by contract, have been carried on during the year.

In the face of an almost universal adoption of the turbine for battleship propelling machinery by the nations of the world, the bureau has in the recent battleships, beginning with the *New York* and *Texas*, abandoned the turbine in favor of reciprocating engines for such vessels. This decision was arrived at after an extensive investigation, including the comparative trials of the two types of machinery in the scout cruisers *Birmingham, Chester* and *Salem*, and in the battleships *Delaware* and *North Dakota*, which render available more exact data on the subject than are available to any other government. It is found that the reciprocating engine is about 30 percent more economical at cruising speed than the turbine and has about the same economy at high speeds.

The steam turbine as now installed in high-speed vessels, notably destroyers and scouts, has greatly extended the range of speed at which these vessels may be safely and continuously driven.

It was found difficult to maintain the Niclausse boilers of the *Colorado* and *Pennsylvania* in efficient condition because of the inability to obtain special parts for these boilers at reasonable prices and without great delay. Eight boilers in each ship have been converted to a boiler resembling the Babcock & Wilcox in construction, at practically little expense, the foundations, furnaces and many of the pressure parts of the original boilers having been used. It is intended to extend this process to the other boilers of these vessels as rapidly as their condition warrants it.

The success which has attended the use of fuel oil in the recent torpedo boat destroyers indicates a probable increase in the extent of the use of this fuel for naval purposes generally. Preparations are being made at the navy yard, Philadelphia, to instruct firemen and water tenders in the methods of burning oil. A lack of such a place of instruction has greatly hindered the development of the art of oil burning in the navy.

The system of forced lubrication of the bearings of main engines has been installed on several battleships and armored cruisers, and will be installed on the others as opportunity offers. This system greatly extends the life of the engine, eliminates bearing troubles, and reduces the quantity of oil required for lubrication.

Turbine-driven blowers, which have proved so successful in the recent destroyers for supplying air to the fire rooms, are being installed on those older destroyers whose condition warrants it, thus eliminating the principal element of weakness in these vessels.

Small foundries capable of handling about 100 pounds of metal have been installed in the battleships, increasing their ability of self-maintenance and reducing cost of repairs.

There is a continual improvement in the economy of coal consumption in the vessels of the service, due principally to the steaming competition. In the direction of this economy the evaporators of many of the vessels have been converted to double effect. There has also been a development of systematic firing induced by analyses of smoke-pipe gases. Most of the largest ships have been equipped with an apparatus for sampling this gas and determining the proportion of CO_2 therein. The result of these analyses has pointed the way to improved economic conditions.

Under the spur of the steaming competition propellers which are more efficient at the cruising speeds have been fitted on the *Kansas* and *North Carolina*, and are to be installed on the *Mississippi* and *Vermont*. As soon as accurate data of the efficiency of existing propellers under service conditions can be obtained it is intended further to improve the efficiency of the fleet as a whole by replacing those propellers which are least efficient at cruising speeds.

On account of the lack of economy of the turbine when driven at the slow speeds compatible with propeller efficiency it has been found necessary to investigate the problem of coupling a high-speed turbine to a slowly revolving propeller shaft, thus conserving both propeller and turbine efficiencies. The collier *Neptune*, recently constructed, has been fitted with reduction-gear machinery intended to accomplish this end, and a similar vessel, the *Jupiter*, which is being constructed at the Mare Island navy yard, will be equipped with electric propelling machinery, in which a dynamo and motors are interposed between the turbine and propeller shafts, both without additional cost to the Government. In the destroyer *Henley* a combination of reciprocating engines and turbines is being installed for the purpose of improving the economy at cruising speeds.

The extensive development of heavy oil engines of the Diesel type that has taken place abroad within the past few years leads to the hope that eventually this type of engine will be available for use in large vessels of the navy. Progress in this country has not been so marked as abroad, but American firms are now taking up the development of this type of engine. The submarines recently contracted for will be propelled by reversible two-cycle heavy oil engines of the Diesel type, developing up to 600 horsepower each. It is hoped that satisfactory proposals can be obtained for the installation of engines of this type in the submarine tender authorized by the last Congress. The existing stage of development does not warrant taking up the engine for installation in larger vessels at this time, but it is hoped that progress in the near future will be such as to warrant this step.

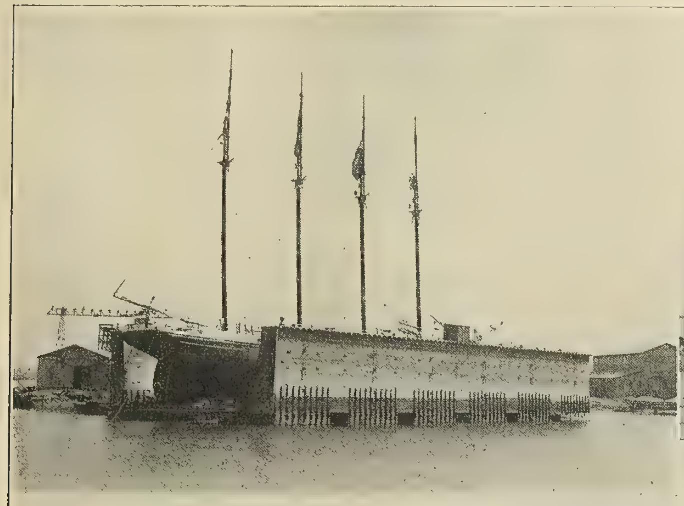
During the year the fitting of sailing launches, dories and other service types of boats with gasoline (petrol) engines has been proceeded with. The collective horsepower of these boat installations now exceeds 4,250, exclusive of installations in submarine boats. The manufacture of a service design of gasoline (petrol) motor has been undertaken at the navy yard, Norfolk, with a view of standardizing all installations. The substitution of oil engines for gasoline (petrol) engines is very desirable, but thus far it has been impossible to obtain these in small units suitable for boat installations. Three types of motors suitable for aeronautical work have been purchased and will be tested during the coming year.

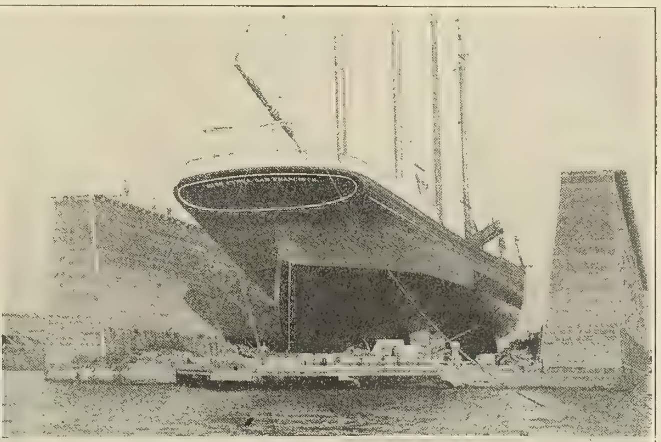
Continued efforts are made to improve the economy of electric installations, and tests of recent turbo-generating sets show a marked improvement over those first purchased, especially at points below full load. It has also been possible to reduce the cost of installation in new ships by increasing the number of distribution centers for lighting, thereby reducing the number of feeders piercing the protective deck. The number of lights carried by a single fuse has also been increased, with resultant decrease in the number of branch outlets. Modifications are being made in the design of searchlight bases and controlling apparatus which will permit either electrical or mechanical control, as may appear desirable.

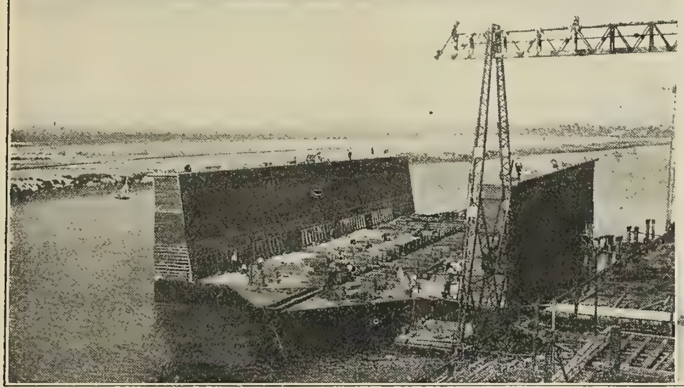
A New Pacific Coast Shipbuilding and Repair Plant

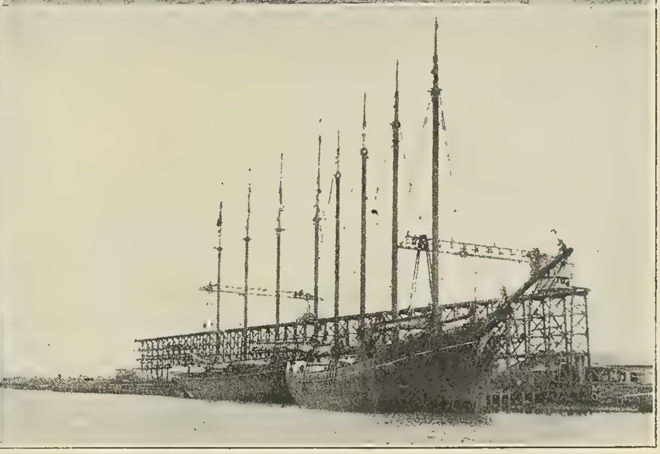
The Craig Shipbuilding Company, of Toledo, Ohio, was well and favorably known on the Great Lakes almost from the beginning of steel shipbuilding there. In 1906 this business was disposed of by sale and we next heard of the Craigs, who found it impossible to keep their hands away from the calling, in Los Angeles, Cal., where Mr. John F. Craig had gone for rest and recreation.

An examination of the water front there in connection with the then small town of Long Beach developed the possibility of a new harbor and shipping facilities. The result, under the direction of Mr. John F. Craig, was the opening up of an inlet which had been previously closed by the tracks of the Southern building Company early obtained plans for the most up-to-date and modern type of floating dry dock designed by William T. Donnelly, consulting engineer, 17 Battery Place, New York. The design of this dock provides for progressive building; that is, while the completed design contemplates a dock 293 feet long in the wings and 350 feet on keel blocks, composed of nine pontoons, and having a lifting power of 5,000 tons, the construction as provided and shown in the photographs is composed of five pontoons, having an over-all length on keel blocks of 241 feet and a lifting power of approximately 3,000 tons, which is more than ample to meet the present needs of the port.









DRY-DOCK OF THE CRAIG SHIPBUILDING COMPANY

END VIEW OF DRY-DOCK

DRY-DOCK UNDER CONSTRUCTION

GENERAL VIEW OF SHIPYARD, SHOWING STEEL SERVICE CRANES

Pacific Railroad, by the providing of a bascule bridge with a 200-foot clear opening, which made possible the creation of a very fine harbor for the now rapidly developing city of Long Beach. For his work in connection with the developing of this harbor, Mr. Craig received the concession of 43 acres of land, upon which there has been erected a complete shipbuilding plant entirely equipped for building hulls and machinery. An ocean-going tug, a dredge and two steamers have already been built by this plant and others are under construction.

As side launching is practically universal on the Great Lakes, the Craig Shipbuilding Company has introduced this method upon the Pacific Coast, and one of the photographs shows the steel service crane which handles material with economy to ships under construction.

In anticipation of the increased shipping that will undoubtedly follow the opening of the Panama Canal, the Craig Ship-

When it is desired to extend the dock additional pontoons will be built and launched. These will then be floated in place and the wings extended over them. This can be done without putting the dock out of commission; in fact, it could be done with a vessel on the dry dock.

In this dock both the pontoons and wings are of timber construction, and are connected together in such a manner that they can be readily detached, which makes the self-docking feature a simple matter. The pontoon to be self-docked is detached, the rest of the dock pumped up and the detached pontoon floated out from under the wings, when the remaining portion of the dock can be lowered and the detached pontoon docked in the usual manner.

The construction of the dock throughout is of selected Douglas fir, put together in the most thorough and substantial manner. The pontoons are very thoroughly protected by

sheathing, and, with the accessibility for examination, little or no trouble is expected from the toredo or other marine worms.

The dock since completion has given excellent satisfaction, and the city and port of Long Beach are to be congratulated upon this addition to its harbor facilities.

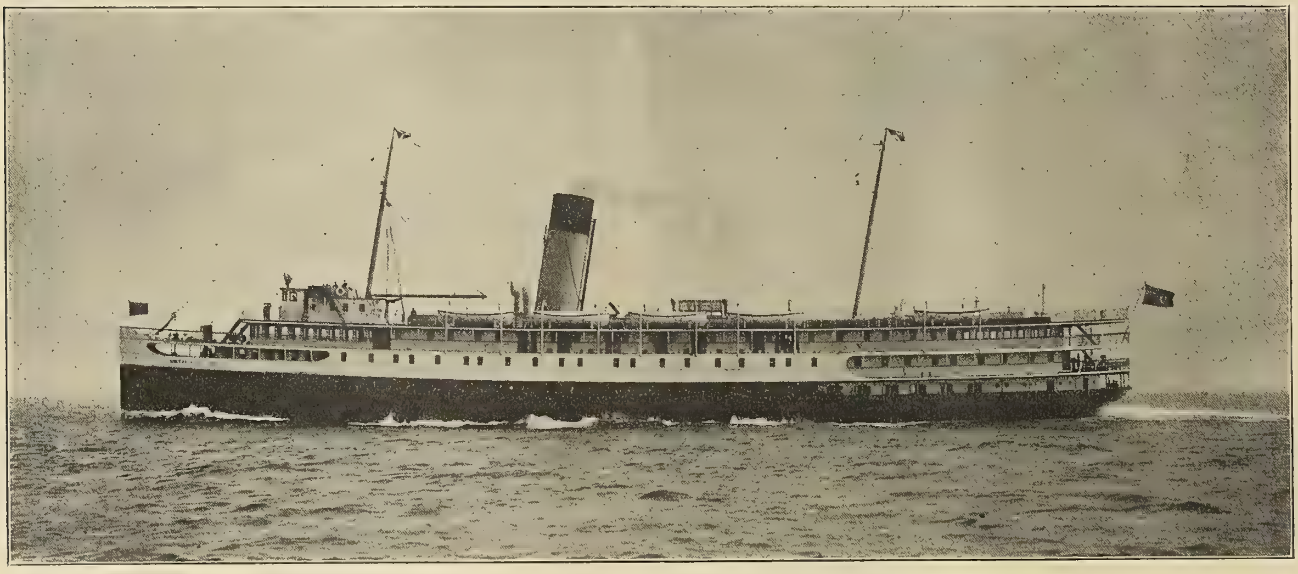
The pumping equipment of this dock consists of ten 10-inch centrifugal pumps, five on each side, operated by a 100-horse-power electric motor. These pumps are capable of pumping the full capacity of the dock within one-half hour. The pumps are operated by vertical shafting from a line shaft along the top of each wing, and the individual control of the pumping is brought about by regulating the flood-gate in each pontoon through which the water is admitted and delivered. This system of controlling the pumping reduces the number of valves to a minimum, and provides a most satisfactory and simple method of operation.

The dock is fully equipped with centering shores and with bilge and keel blocks of the latest design. Compressed air is provided for operating air tools, and it is certain that this dock, in connection with the shipbuilding plant, will be able to render the most prompt and efficient service in the matter of dry docking and ship repair work.

The Canadian Pacific Railway Company's Steamer Princess Alice

The latest addition to the fleet of the Canadian Pacific Railway Company is the finely modeled passenger steamship *Princess Alice,* built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at their Wallsend shipyard. The vessel is 290 feet long, 46 feet 2 inches beam, with a draft of 12 feet 6 inches. In many respects she is similar to the other well-known steamers previously built by the same concern for service on the Pacific coast of Canada.

She is an 18-knot ship, the main engines consisting of one set of four-crank triple-expansion reciprocating engines, balanced on the Yarrow, Schlick, Tweedy system. The cylinders are 27, 42, 48½, 48½ inches diameter by 39 inches stroke. Steam is furnished by four single-ended boilers, 15 feet 7 inches outside diameter, 12 feet long, the steam pressure being 180 pounds per square inch. Either coal or oil can be used as fuel; the oil-burning apparatus is of the Wallsend-Howden system; the liquid fuel pumps of the Weir type. California oil will be used, and this is stored in the double bottom and deep tanks. The boiler furnaces are clear of brick work. Two double inlet fans are supplied by Messrs. M. Paul & Company, Dumbarton. The condenser is of the Uniflux type, and is independent of the engine framing. Dual type air pumps are used, and all of the pumps are independent, none being connected to the main engine.



LATEST ADDITION TO THE CANADIAN PACIFIC RAILWAY COMPANY'S FLEET, THE PRINCESS ALICE

The passenger accommodations include commodious cabins, extending the whole length of both the upper and promenade deck. On the main deck aft is the dining room, paneled in beautiful Italian walnut and finished in decorations of white enamel and gold. Below the dining room is a restaurant, with seating accommodations for about 100 persons at small tables. On the promenade deck, forward, is the observation room, with large plate glass windows on three sides. At the after end of the same deck is the first class smoking room, furnished in fumed oak. The oak walls are to be relieved with hammered copper panels beautifully designed, and representing scenes of North American Indian life and various Canadian subjects. On the upper deck, both forward and aft of the engine and funnel casing, there are large social halls or music rooms. Both the ventilation and lighting of saloons, corridors, staterooms, kitchens, etc., have been carefully studied and lavishly executed. The location of the public rooms is such that the passengers can have an uninterrupted view of the magnificent scenery through which the vessel passes.

Tug Boat Frank Tenney

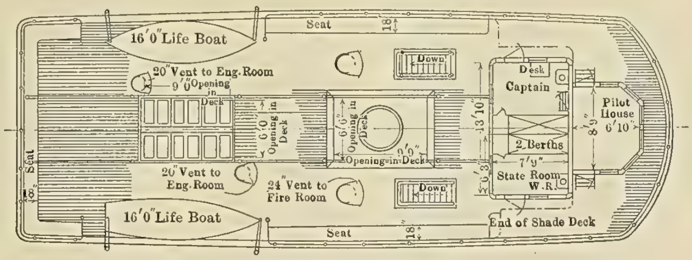
A steel tugboat was recently completed by the Maryland Steel Company, Sparrows Point, Md., for the Spanish-American Iron Company, for use between Santiago and mines at Daiquiri, Cuba. The hull is of steel, built to the highest class American Bureau of Shipping. The length over all is 125 feet 6 inches; between perpendiculars, 119 feet; the beam molded, 25 feet; depth, molded, 13 feet, and the draft 10 feet.

The deckhouse is of steel and the pilot house of wood.

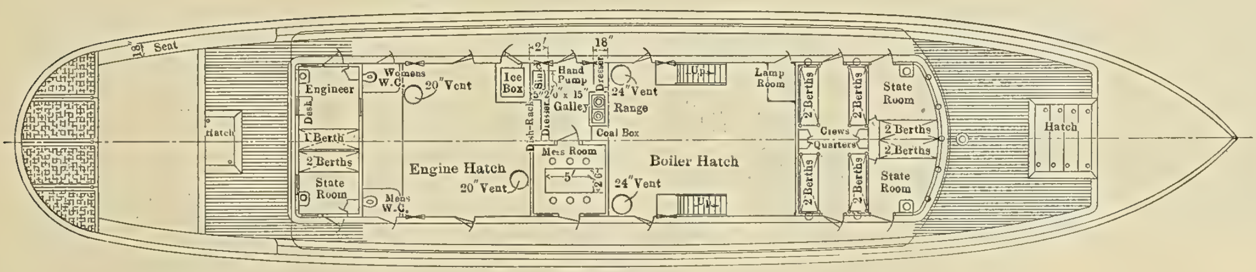
There is one wooden mast equipped with one boom, capable of handling a load of 5 tons. The joiner work is of cypress, tongued and grooved, trimmed in oak.

Steam is furnished by one Scotch boiler, 13 feet diameter by 11 feet long, carrying a pressure of 180 pounds per square inch. There are three 42-inch furnaces, and all the tubes are 3 inches diameter.

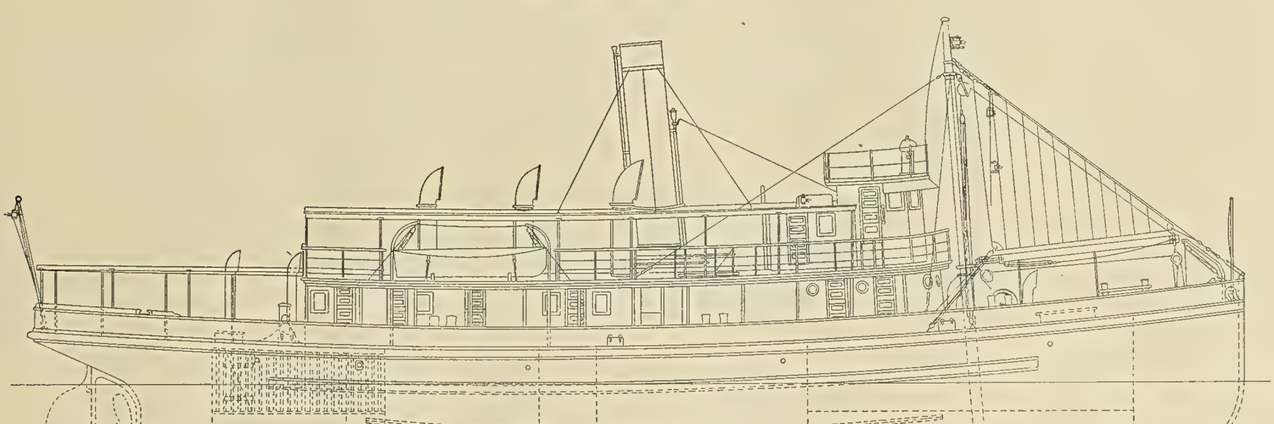
The propelling machinery consists of one triple-expansion engine, with cylinders 12½, 20½ and 34 inches diameter, with a common stroke of 24 inches, designed to drive the ship at a speed of 11½ knots. The condenser is of the surface type, and there are circulating, bilge and feed pumps on the main engine. The independent pumps include the sanitary, donkey, circulating and wrecking pumps. The boiler is supplied with an injector.



PLAN OF BRIDGE DECK



PLAN OF MAIN DECK



GENERAL PLANS OF THE TUG BOAT FRANK TENNEY

The deck auxiliaries include a steam windlass, winch, gypsy and steering engine. A fresh water tank with a capacity of 600 gallons is provided. The safety appliances include one 16-foot double-ended lifeboat and one 16-foot square stern boat. The general arrangement and provision for the officers and crew are evident from the drawing shown herewith.

A new 100-ton tug, the *John C. Stuart*, designed by W. I. Babcock, of New York, has just been completed by the Staten Island Shipbuilding Company, Port Richmond, N. Y. The boat is 100 feet long and equipped with powerful fire pumps.

Light Draft Steamers Carolina and Virginia

The steamers *Carolina* and *Virginia*, recently built at the works of the Newport News Shipbuilding & Dry Dock Company for the Albemarle Steam Navigation Company, are intended for light draft river service. The principal characteristics of these steamers are as follows:

	Carolina.	*Virginia.*
Length between perpendiculars	121 feet	104 feet
Length over all	130 feet	115 feet
Beam molded	25 feet	25 feet
Beam on decks	27 feet	27 feet
Depth molded at side	9 feet	9 feet
Cargo-carrying capacity at a draft of 6 feet	120 tons	100 tons
Gross tonnage	334 tons	292 tons
Net tonnage	206 tons	179 tons
Staterooms to accommodate	18 persons	16 persons
Saloon space to accommodate	85 persons	75 persons
Crew	26 persons	26 persons
Speed	10.5 miles	9.6 miles

The hull is of an extremely heavy and substantial construction. The shell plating is 15 pounds throughout. The keel plate is 20 pounds reduced to 17½ pounds at the ends, and the frames, floors, etc., are proportionately heavy. Three watertight bulkheads are also fitted. Heavy ties and stringers are worked on the decks. Steel coal bunker bulkheads with heavy coamings are also fitted. The sides of both hulls are flared out to the guards in order to protect the deck from piles, etc., when landing at the docks. The entire construction is of simple design and amply strong for the rough service in which these vessels are engaged.

The saloons present a very attractive appearance. The

joiner work and the hardware are plain and substantial. The decks in passengers' quarters are covered with the best linoleum, and the staterooms are carpeted.

Each vessel is fitted with electric lights, searchlight and generator, the generators being of sufficient capacity to light up the ship and in addition the lights which the company has installed on all their piers and in their warehouses.

The *Carolina* is fitted with a compound engine, a Kingsford leg boiler of 1,560 square feet heating surface, 42 square feet of grate surface, and carrying a working pressure of 125 pounds. It is also equipped with a surface condenser of 500 square feet cooling surface and independent auxiliaries.

The *Virginia* is fitted with a duplicate of the engine of the *Carolina,* a smaller boiler of the same type as that of the *Carolina,* designed, however for a working pressure of 145

LIGHT-DRAFT RIVER STEAMER VIRGINIA

pounds. A jet condenser is installed in this ship with independent auxiliaries.

On trial the *Carolina* developed 225 indicated horsepower, and attained a speed of 10.5 miles per hour, and the *Virginia* developed 200 indicated horsepower and attained a speed of 9.5 miles per hour.

The *Carolina* runs between Edenton, N. C., and Murfreesboro, N. C., and the *Virginia* runs between Franklin, Va., and Tunis, N. C., the latter route being on the Blackwater River, which is an extremely narrow stream with sharp bends, making it necessary to reduce the length of the *Virginia* in order that she could navigate this tortuous channel.

These vessels carry a general cargo of freight throughout the year, and at certain seasons handle large quantities of peanuts, cotton, fertilizers, etc. The holds of both vessels are arranged in such a manner as to be available for the stowage of through freight.

As these steamers are operated both day and night, the ingenious arrangement of lighting the piers and warehouses from the generators of the steamers greatly facilitates the handling of freight during the night work.

U. S. Battleships Oklahoma and Nevada

On the 4th of January bids were opened at the Navy Department, Washington, for the construction of the two new battleships *Oklahoma* and *Nevada.* Three bidders submitted bids and proposals under the eight-hour-a-day law provided for by Congress in making the appropriation for said ships. The William Cramp & Sons' Ship & Engine Building Company, of Philadelphia, while not submitting a bid, stated they could not do so because, in the event of its being successful, the company would have to adopt the eight-hour law for all the work throughout its entire plant, a condition which it at the present time considered inexpedient.

The bids of the three firms submitting proposals were as follows:

The Fore River Shipbuilding Company, of Quincy, Mass., offered to build one ship on the Department's plans and specification for $5,980,000 (£1,230,000), which is within $20,000 (£4,100) of the appropriated sum. As alternative bids it proposed to build one vessel with Curtis turbines, instead of reciprocating engines, provided by the Department's specifications, $5,935,000 (£1,220,000), or one vessel with combination machinery, consisting of Curtis turbines and connected reciprocating engines of sufficient power for cruising speeds, for $5,955,000 (£1,223,000).

The New York Shipbuilding Company, of Camden, N. J., offered to build on the Department's plans one vessel with reciprocating engines for $5,965,000 (£1,225,000). Also to build one vessel on the Department's plans, but exclusive of magazine refrigeration for $5,926,000 (£1,217,000). In each case its bids provided for the use of nickel steel in place of a special steel to be used in hull construction called for by the Department's plans. Both bids of the New York Shipbuilding Company were for reciprocating engines.

The Newport News Ship & Engine Building Company, of Newport News, Va., offered to build one vessel for $6,450,000 (£1,323,000), or $450,000 (£92,500) above the appropriation allowed by Congress.

The vessels in question are of 27,000 tons displacement, to have a speed of 20½ knots when developing about 12,400 indicated horsepower on each of two shafts. The general arrangement of the engine room machinery differs somewhat in these two ships as compared with former ships, in that the main and auxiliary machinery is placed in four watertight compartments, obtained by dividing the engine space by three fore-and-aft continuous bulkheads (the whole length of the engine room being about 60 feet).

The main engines, being placed in the outboard compartments, are of the four-cylinder triple-expansion type with two low-pressure cylinders. The exhaust from each low-pressure cylinder is led directly to its own condenser placed athwartships, there being in all four condensers, two in each compartment. In each branch of the low-pressure receiver, leading from the intermediate-pressure cylinder, there is fitted a gate valve, enabling the shutting off of either low-pressure cylinder. Besides the main engines there are placed in each outboard engine room three forced lubrication pumps, sea suctions and discharges, working platforms and operating, etc.

On each side of the center-line bulkhead there is an engine room containing two centrifugal circulating pumps, two main air pumps, one feed tank, all of which are interconnected from one engine room to the other. Besides the auxiliaries enumerated there are placed in each of the compartments in question two main feed pumps, two fire and bilge pumps, one Bureau type feed heater and one forced lubrication tank.

In the boiler room there are twelve large-tube, express-type watertube boilers for oil fuel firing only. They are arranged in three athwartship compartments with four boilers in each with one common fire-room. There is one smoke stack for all of the boilers, into which the uptakes from each boiler are led.

The time of completion for the construction of each of these vessels is thirty-six months from the date of signing the contract.

Contracts have been awarded to the Fore River Shipbuilding Company for one battleship with combination machinery of Curtis turbines and reciprocating engines, and to the New York Shipbuilding Company for one battleship with reciprocating engines.

New Menhaden Steamers for the Atlantic Coast

BY MARTIN C. ERISMANN

In July of last year three menhaden boats, completed in nine months to the order of the Atlantic Fertilizer & Oil Company, of New York, were placed in commission and are now actually engaged in fishing off the New England coast. This industry dates from the '60's, and is one of long standing, but it is only of recent years that it has been possible, through greater demand of the products of the menhaden fishing, to enlarge the plants of the companies engaged in this business. For years the boats were of small size, and though they paid well were not as well adapted, in point of view of modern arrangements, as the new boats just put in service.

The menhaden, or pogie, as the fish are nicknamed, are found in schools all along the Atlantic seaboard, from the Caribbean Sea to the Eastern Coast of Maine. The fish are detected in many ways by lookouts from the vessel, depending upon the weather and sea conditions. When a school is sighted a purse seine is shot overboard from a seine boat, two usually being carried, one on each quarter; the seine is brought alongside, and the fish dipped out and transferred to the fish hold.

A full cargo aboard, the vessel makes all speed to the factory, where the fish are placed in large boilers and then pressed to extract the oil, and the residue is used as the basis for fertilizer. It is a substitute for German potash, bone phosphate, which fertilizers generally contain. The oil finds an extensive market in the leather tanning trade and for tempering of steel, taking the place of linseed oil by reason of its cheapness and efficiency. For lighting purposes in mines it is used for its uncombustible properties.

The vessels which are the subject of our description are the *Martin J. Marran, Rollan E. Mason* and *Herbert N. Edwards.* They were built under the direct supervision of Capt. N. B. Church, of Tiverton, R. I., manager of the fishing department, Atlantic Fertilizer & Oil Company. Capt. Church has always been identified with the menhaden fisheries. In 1860, realizing the possibilities of a steamer, he and his six brothers, who were all interested in the pogie business, commissioned Nat Herreshoff, of Bristol, R. I., to built a vessel, which was subsequently called the *Seven Brothers.*

The new vessels were designed by the firm of B. B. Crowinshield, naval architects and engineers, of Boston, Mass. The three hulls were built, two by Cobb, Butler & Company, of Rockland, Me., and one by A. D. Story, of Essex, Mass. The machinery installation was put in the hands of the Portland Company, of Portland, Me. The boats are of the usual type of vessel for this trade, except that they are larger and better equipped in every way, from a point of view of efficiency, speed and comfort. The dimensions follow:

Length over all	165 feet.
Breadth	23 feet.
Draft (loaded)	12 feet 9 inches.
Depth	13 feet.
Indicated horsepower	600
Speed	13 knots.
Capacity of fish hold	4,000 barrels.

The hulls are of wood, the keel, stern, sternpost and deadwood of oak, the framing of white oak, the planking and ceiling hard pine, 4 inches thick, with hard pine bilge strakes. In the vicinity of the boiler a steel beam with large gusset plates was worked in to tie the boat together. It was the intention to work under the planking at the line of the main deck a steel stringer to strengthen the top member of the structure, but these were omitted owing to possible delay in the date of delivery.

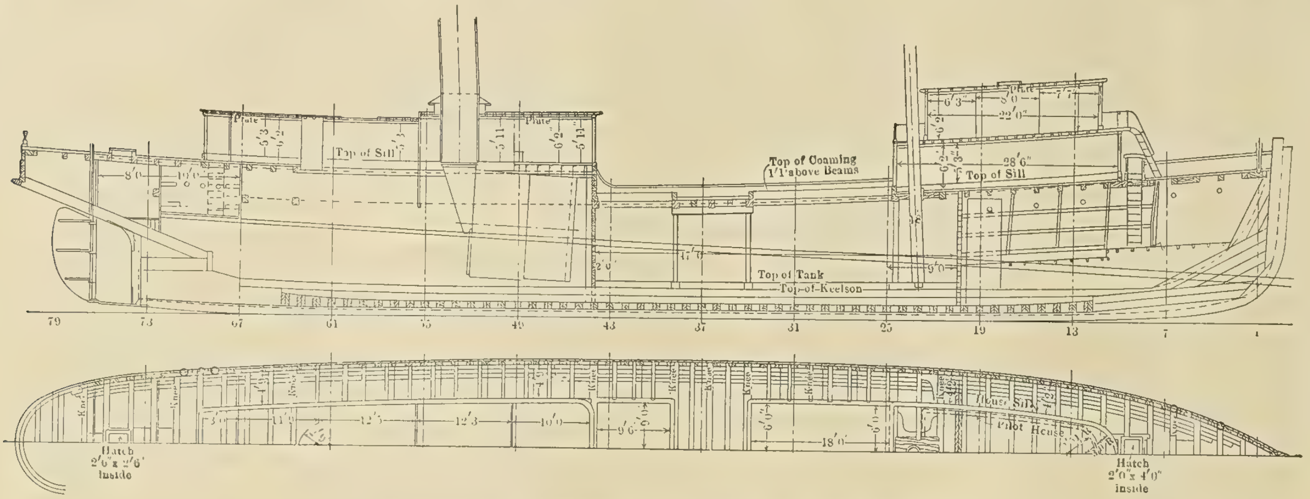
MENHADEN STEAMERS ON THE STOCKS

The accommodations consist of a two-story deck house forward and a house located on the raised poop aft, part of the after house comes over the engine and boilers, and in the forward end is located a winch room. Two large hatches in the waist give access to the fish holds. The crew of twenty-eight men is housed in the forecastle below the main deck, forward of which there is a chain locker and store room; the house on the main deck is given over to the mess room and galley; above is the pilot house, aft of which is the captain's room, with two berths and a guests' cabin, also fitted with two berths. A toilet and wash room is located to port.

The forward end of the after house is given over to the deck winch for handling the dipping scoops to get the fish from

the seine to the fish hold. The hoisting engine is a Hyde cargo winch, with cylinders 10 inches by 10 inches, and capable of handling 4 tons.

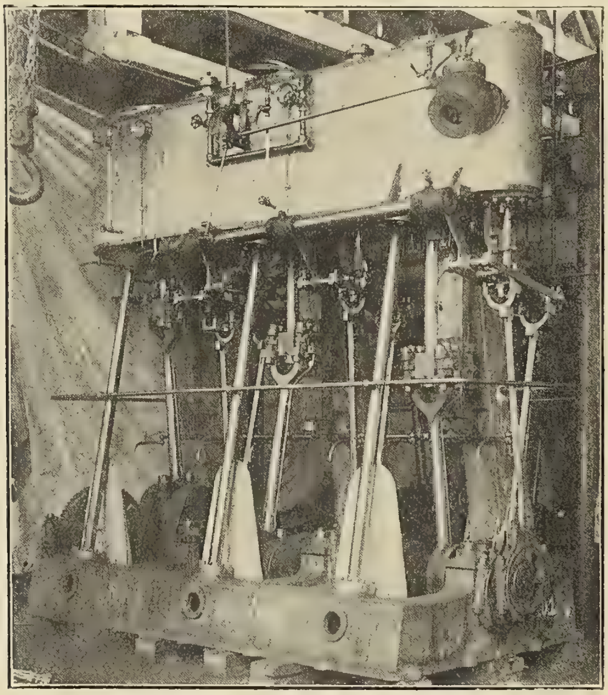
Aft of the winch room is located the boiler casing, engine room skylight, chief engineer's room and a cabin for the mate and pilot. A toilet is fitted in after port corner, and is accessible from the deck; to starboard is located the entrance to



INBOARD PROFILE AND DECK PLAN OF THE MENHADEN STEAMERS

the after cabin on lower deck, to accommodate eight men at the height of the season, when double crews are carried, to man four seine boats, which are then carried. In the run a store room for nets and salt is fitted. The rudder gear is of the hand type, and stocks of steel fitted with wooden blades.

The appearance of the vessels is very good, and their ability as fast, economical and comfortable boats leaves nothing to



TRIPLE-EXPANSION ENGINE FOR ONE OF THE MENHADEN BOATS

be desired. The engine installation, which is very complete, has been successful and given no trouble, and with the vigorous conditions of service imposed, which preclude time off for repairs, simplicity and handiness were the keynote of the design.

The boiler of the single-ended Scotch type is fitted with three Morison suspension furnaces. The particulars follow:

Length	13 feet 2 inches
Diameter	15 feet 7 inches
Shell	1 ¼ inches thick

258 tubes (No. 1 B. W. G. seamless drawn steel) and 58 stay tubes ¼ inch thick by 3 inches diameter.

Heating surface	2,521 square feet
Great area	68 square feet
Working pressure	180 pounds
H. S. to G. S.	37 to 1
Coal per square feet of grate per hour	17 pounds
Water evaporated per pound of coal	9 pounds
Pounds of water evaporated per square feet of grate per hour	153 pounds

The engine, of the three-cylinder, inverted triple-expansion type, with cylinders 13½ inches by 21¾ inches by 36 inches diameter, and 24 inches stroke. On trial, the engines developed 606 horsepower, at a steam pressure of 180 pounds, with 132 revolutions per minute. The engine was designed to be as simple in construction and operation as was consistent with economical operation and protracted service, with a low cost of up-keep and a minimum of repairs. The cylinders, cast separately, of a tough grey iron, are bolted together; relief valves are fitted, all being 1½ inches and set at 195 pounds for the high, 100 pounds for intermediate and 30 pounds for the low. The supporting brackets have the slides cast on, and the front columns are of the forged type. The valves are all of the piston variety, there being two on the low-pressure cylinder and one each for the high and intermediate-pressure cylinders. The cross-heads are of cast steel and lined with composition jibs; the valve gear is of the ordinary link type, fitted with a steam cylinder, a lever handling both the reverse gear and throttle, insuring quick and positive operation when maneuvering or coming alongside the dock to discharge fish.

The bed plate is cast in one piece, with large flanges and reinforcing webs. At the after end there is cast on a bracket for the hand pinch wheel. The bearings on the bed plate are six in number, with ample surface to prevent heating under any circumstances, the lining being of Parsons antifriction white metal. The crankshaft is of forged steel and of the made-up type, 8 inches in diameter and solid, and forged by the Cape Ann Anchor Works. The connecting rods are of forged steel, with brass boxes at both ends; the lining of the boxes is of Parsons white metal.

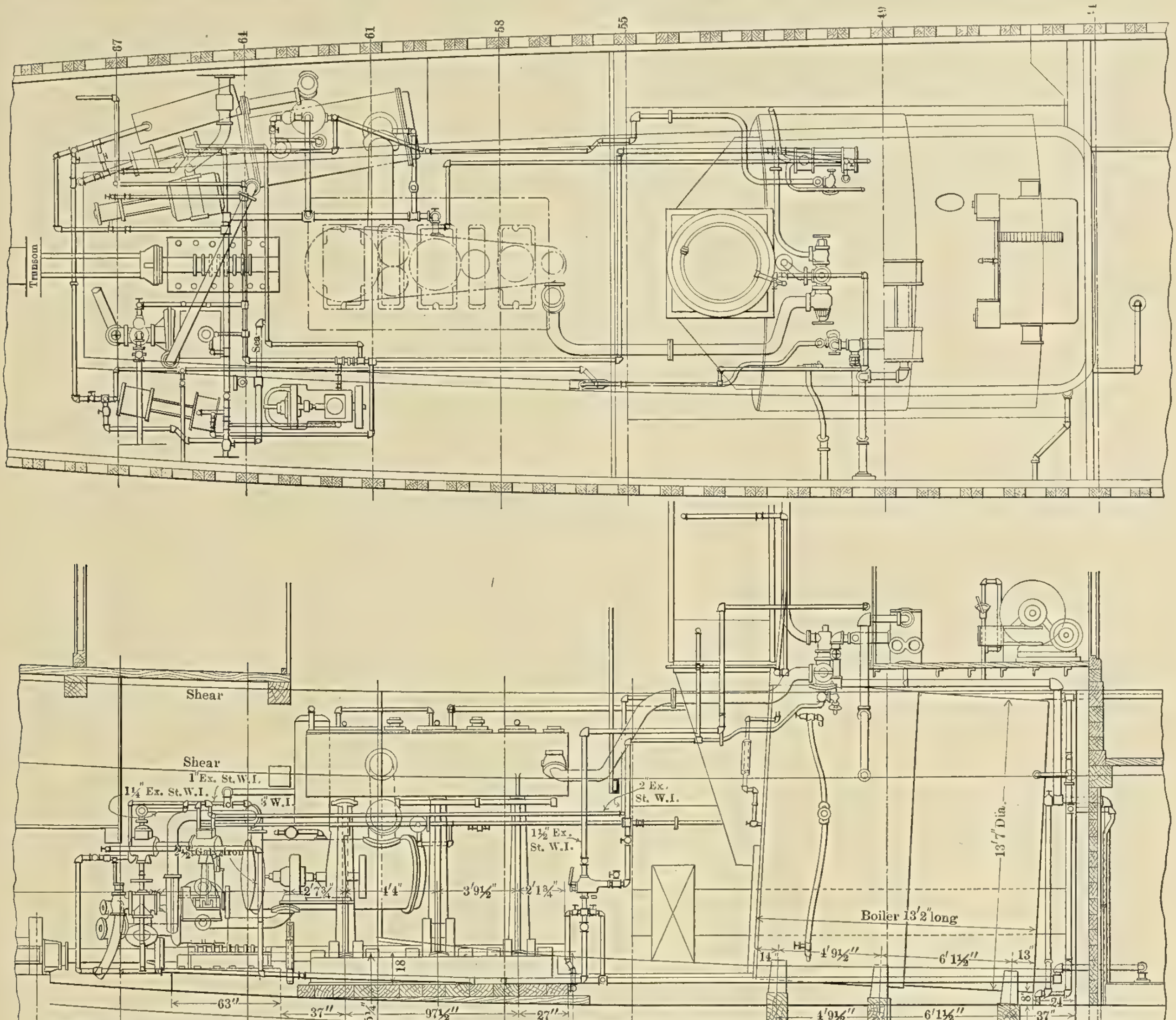
The oiling system is a combination of what has been proved to be in this type of installation the best for the purpose, and consists generally of a reservoir located on the starboard top of each cylinder. Pipes are led from each of the six compartments of each reservoir by means of wick feeds to the

points of lubrication. The slides are fitted with water circulation to obviate heating, giving better lubrication by reason of the lower temperature. The valves are of cast iron and of the piston type.

The weight of the engine complete is about 20 tons. The condenser, 94 inches long by 38 inches diameter, is separate from the engine and is cylindrical, the tube sheets of composition 7/16 inch thick, with 800 ⅝ inch diameter brass tubes, and a cooling surface of 912 square feet.

searchlight, 14 inches diameter and 20 amperes, is fitted on the pilot house. An ash ejector of the Portland Co. type discharges 8 inches above the waterline. The main steam piping is of copper, 5¼ inches diameter, as are all other steam lines under pressure, other piping of extra strong and standard wrought iron pipe.

The coal bunkers, of 10 pounds steel plating, have a capacity of about 75 tons of coal. The water tanks placed in the bottom of the fish well contain 7,800 gallons of water.



MACHINERY ARRANGEMENT OF THE MENHADEN STEAMERS

The circulating and centrifugal pump were manufactured by the Morris Machine Works, and are both fitted with a 6-inch by 6-inch cylinder and 7-inch suctions.

The sea suction is 3½ inches diameter to the auxiliary feed pump, which is a 7½-inch by 4½-inch by 10-inch Blake horizontal duplex. The air pump is an 8-inch by 14-inch by 12-inch Blake horizontal simplex. The boiler feed is a 6-inch by 14-inch by 6-inch Blake horizontal duplex, and the boiler circulating pump 5¼-inch by 3½-inch by 5-inch Blake horizontal duplex.

An electric outfit of 5 kilowatts, 110 volts capacity, at 425 revolutions, consists of a Portland Company standard generator on the same bed plate with a Sturtevant 5-inch by 5-inch engine. This outfit gives thirty lights all through the ship, and will stand an overload of 30 percent. A Rushmore

The thrust block is of the usual horseshoe type, with eight collars faced with babbit. The propeller is 8 feet 6 inches diameter by 11 feet 8 inches pitch, solid, four-bladed, manufactured by the Front Wheel Company of Albany, N. Y.

The boats have, since being put in service, proved to have exceeded their speed, and the specified capacity of 4,000 barrels was entirely met. At sea, in rough conditions, either light or loaded, their behavior has been satisfactory, having such stability as makes them easy, comfortable and habitable.

A twin-screw passenger steamer of 17,050 tons displacement and 10,000 horsepower has been contracted for with the Vulcan Shipbuilding Company, Stettin, Germany, by the Scandinavian-American Line. The ship will be 540 feet long, 62 feet beam, 41½ feet depth, with a designed speed of 17 knots.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Broken Crankshaft

One accustomed to marine engines for freight steamers will always consider an engine for a hopper-dredge to be of very heavy design, the crank shafts being at least 15 percent more in diameter than Lloyds or Veritas require. The following will show that this may be necessary.

On the steam hopper-dredge "N" a triple-expansion engine of about 600 indicated horsepower, working with 160 pounds steam pressure, and making 140 revolutions per minute, was used to drive the large sand pump. The suction pipe was connected directly to the pump suction, and no grating was fitted in the suction pipe. This vessel was used for the deepening of a sea harbor. There were many stones, large and small, to be removed, and when the pump was working it made such a terrible noise that nothing could be heard in the engine room. One day it was found impossible to start the engine. The turning worm gear was put in, and with a tackle on the end of the turning lever the engine was moved, breaking a large stone, which allowed the engine to be started.

Some days afterwards, again a terrible noise was heard in the pump and immediately the engine raced badly. After stopping it was supposed that one of the vanes of the pump was broken; but, after taking off the cover and examining the pump, all four vanes lay on the bottom of the pump. A new set was ordered and put in place; it was made heavier than the first. For a week the engine ran very well until a place was reached where many stones had to be sucked away. The pump then began to make much noise and some hours after the starting a heavy knock was heard and again the engine began racing. But now it seemed that the pump shaft had been broken.

It was clear that something else had to be done, as it was impossible to continue the work as things were. The suction pipe led directly to the pump suction. This arrangement was now altered. A large tank made of ½-inch plates and 3-inch angles was built in the ship close to the pump's inlet branch; on the top of the tank the suction pipe was connected. The tank had a large cover bolted on, allowing all stones to be cleared away.

This seemed to be a good arrangement, as all large stones were drawn into this tank and not into the pump. It often occurred afterwards that the pump did not work on account of the accumulation of stones in the tank, but they could now be easily removed; a sluice valve was fitted on the top of the tank to prevent a large quantity of water filling up the suction pipe.

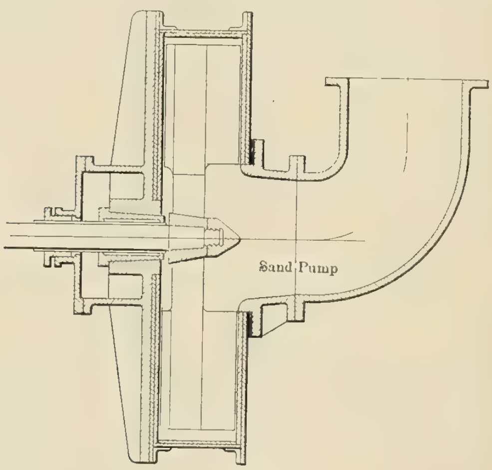


FIG. 1

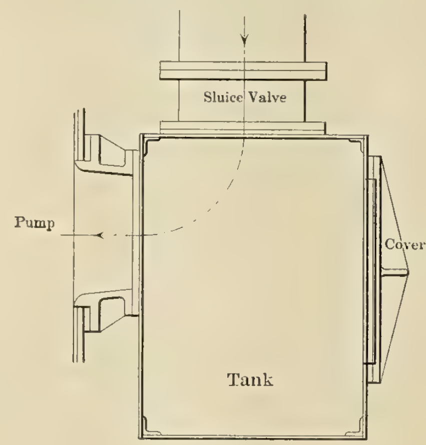


FIG. 2

Figs. 1 and 2 show the old and new arrangements. From the foregoing it is clear that in a dredge the crank shafts must be very heavy and the turning gear very strong, and the whole engine heavier than a common marine engine. Auxiliary steam pipes for admitting steam direct to the medium-pressure and low-pressure receivers should be fitted, as it is often impossible to start the engines when taking steam in the usual way, owing to the stones, mud and other matter accumulated in the pump; but this, of course, gives a high steam pressure in the receivers and cylinders, the walls of which must be made much stronger to withstand this extra strain.

Engineer.

A Little Experience

Strange, isn't it, what a great deal of damage can be done on board a ship, if, from one cause or other, an engineer, or assistants, fail in some little duty or other? Perhaps being a little slack in methods could account for the "failing to do."

A boiler becomes short of water, high-pressure steam, and brisk fires. It may be that in feeding a set of boilers this particular one has been keeping a steady waterline, and the valve allowing such a good regular feed that the "engineer on the watch" has been giving more attention to the others than he gives this one. It has been keeping a steady feed for watches; but, for some reason or other, the check valve stuck. It does not take long, when you are maintaining 210 pounds of steam and doing twenty-one knots, to evaporate water from a working level to a dangerously low degree. The failure of the check to work has been overlooked because of some little trouble elsewhere in the boiler room. The line above needs no filling in, we know. The engineer in the engine room has failed to detect the gradual warming up of the crank pin, for it has given absolutely no trouble for trips.

What is the result? In the case of the engineer on the boiler, so in this. He may be lucky—he may not. Now all this brings back to me a little experience I had a couple of years ago while engineer on watch in a foreign port.

We had two main boilers connected up for port use—donkey boilers—which arrangement always held, as the electric lights, refrigerator, and deck machinery were always working in port. These two boilers were each equipped with two separate feed pipes and checks, one set being from the main and the other set from auxiliary valves. Both were the same size pipes and valves, but connected to the boilers in regular fashion, the main checks being at the passage side of the boilers for ordinary use at sea, and the auxiliaries at the other side, which at no time was confusing.

In port we had two firemen on the donkey boilers, one being in charge, and a reliable man, and the feeding of the boilers was left with him. There were three watches, with two men on each watch. Now, although the boilers were looked after well by the firemen, the junior engineer of each watch had to take a periodical walk round and examine things, and report to the senior engineer of his watch. This was at such times that the engine room staff would not be down below overhauling, for then there would always be some one around. On Sundays, in port, however, it is obvious that the presence of the engineer below all the time, everything going smoothly, would not be required. I have explained just how the watch was set, who was on watch and who was in charge, so it can be the more readily understood how the following came about.

This particular watch was Sunday afternoon, the engineers relieving about one o'clock and the men below changing at two. In the morning a burst had occurred in the auxiliary feed pipe, and the engineer on that watch had been obliged to change over on to the main feed. He reported this to his relief, as the pipe would have to be removed to the repair shop on the next day, and the firemen changing would be notified by the firemen going off. Here is where the trouble began. The firemen forgot to notify their relief, and the engineer, not noticing the time, had let two o'clock pass and had failed to see the relief come on, as he should have done. Everything was all right at two o'clock.

About twenty minutes past two the electric lights went out. This is all the alarm that was needed on that occasion. We all ran down the engine room ladder, and, passing the electric platform, found the man in charge there had shut off his engines, as a heavy knock in the cylinders gave an indication of water. We raced through to the boiler room and met the fireman coming out to find us. He said he could not get water in one boiler while the other one had filled up, although he had the valve shut. The feed pump was working well, but we slowed it down. When the fireman showed us the check valves we saw at once what was the matter; he was operating the checks which had been shut off, while the main checks (which had been put into commission since the last time he had been on watch) were in exactly the same position —one open and the other almost shut—since he relieved his mate. One engineer opened the blow-off valve from the full boiler, and one of us quickly ascertained how long the water had been out of the glass of the other, for while one had a full glass and only knows how much higher, the other was minus a reading the other way. The fireman said he was just coming up as the water had just gone out of sight. A very sorry plight, but we opened the check valve to the "empty boiler" and closed the other. The water just showed in the bottom of the glass, as the other boiler, due to blow-down operations, was just level with the top of the gage. A sigh of relief went round, because it was a few minutes before the water showed. No undue risk had been taken, of course, as the water, we knew, would be well above the crown plate; but when these things happen during the quiet of a Sunday afternoon, lights out, and one boiler with a full glass and the other with a full "steam" glass, all in a few minutes, and the thoughts of "what might have been," make one breathe a sigh of relief when all is fixed right again. The electric light was started and found that all was well.

The only thing that this experience brought about was what I mentioned in the beginning of this letter: "Do not be slack in methods," even if you know all is well. This man had been opening the wrong checks, because his relief had failed to tell him of the change, and the engineer had just overstepped the relief of the men below by twenty minutes. The fireman had noticed the water getting higher in the one boiler, but had shut the check which had no connection from his pump, leaving meanwhile the main check almost full open. When he found the other boiler losing water he opened the check (auxiliary) more and started the pump quicker. This gave the full boiler more mater. I suppose the queerness of the thing must have puzzled him, and when he was debating with himself as to the best thing to do the lights went out. That decided the question for him. He should have called the engineer at the first sign of trouble, but this he failed to do. The junior engineer was down below every fifteen minutes after that during that watch. He had had enough for one watch. N. A. Y.

New York.

Rivet Out of Ship's Side Under Water Line

Every sea-going engineer is fairly strongly impressed with a knowledge of what is meant by the static head of water. It is not everybody, however, who has seen it applied in such a startling manner as occurred during the voyage of an oil tank steamer. The demonstration arose out of the snapping of a rivet in the ship's side. The rivet fell right out and the rivet hole was considerably below the level of the water line. As the engine room lay the full width of the vessel, the first thing that drew the attention of the engineer to the occurrence was a solid stream of water squirted right across the engine room, falling, as luck would have it, full on the dynamo. The commutator promptly flashed over, and all the ship's lights were put out. As hurry-up measures were necessary, a wooden plug was quickly made and hammered into the hole. This stopped the water for a while, but owing probably to the working of the vessel, the plug kept coming out and giving the engineers douche baths. These, though highly recommended by the doctors, occurred at inconvenient times, so that it was resolved to try something more permanent.

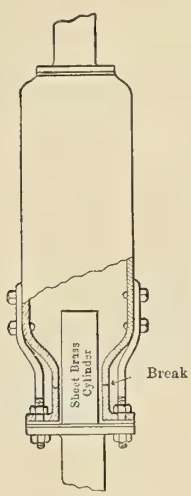
A long strip of wood was first secured which could be passed through the rivet hole. To the middle of this was fastened the end of a long piece of sail-twine. While this was being done a long bolt was taken and screwed down to within an inch of its head and a broad washer was put on to it. In front of the washer was placed a small rubber joint. When all was ready the vessel was stopped and the plug was taken out of the ship's side. The long strip of wood with the string attached to it was pushed through the hole and allowed to float to the surface outside the vessel, the string being paid out to allow for this. When it reached the surface it was pulled up to the deck and the string was taken off the wood and fastened to the end of the bolt. The bolt was next dropped into the sea and by means of the sail twine it was hauled up to the rivet hole and by careful management worked into the hole. The end of the bolt coming into the engine room was then held by the fingers while another rubber joint was put on. This was followed up by another broad washer and then a nut, which was screwed up hard. This made a sound job of the repair, and no further trouble was experienced from this cause.

Southampton. T. D. L.

Repairing a Delivery Air Vessel

Some years ago, while our ship was lying in harbor at Port Louis, Mauritius, the delivery air vessel (cast iron) belonging to one of our bilge pumps was accidentally broken. The break being, however, a clean one, we had little difficulty in effecting a successful repair.

As may be seen from the accompanying diagram, the fracture occurred across the throat of the air vessel at its lower or inlet end. To make good the damage we constructed a flanged cylinder of 1/16-inch sheet brass, making it small enough in diameter to fit loosely into the throat of the air vessel, and of a length sufficient to reach for several inches up into the chamber; in the flange of the cylinder holes were, of course, cut to correspond with those in the flanges between which it was to be fitted. Two wrought iron palm bolts were also made, and on these being properly secured in the required position on the sides of the chamber the whole outfit was built up as shown. The job was completed by pouring into the chamber a grouting of live Portland cement till it filled completely all space around the brass cylinder. The outlet pipe from the top of the air vessel was then carefully rejointed, and, to give the cement a chance to set, every-



FRACTURED AIR VESSEL

thing about that air vessel was left undisturbed for the remainder of our time in port.

In dealing with Portland cement it is well to remember that in setting it expands; also, that if the setting can by any means be retarded, the result, according to expert opinion, will be an enhanced ultimate strength, this strength being reached in about six months' time.

Notwithstanding the fact, however, that in our case the cement had only a few days in which to set before it was tested, the result of that test was all that could be desired, for there was not even a "weep" from the fracture then, nor all the time that the air vessel remained in service. Apart from other considerations, there can be little doubt that the comparatively unvarying temperature of our bilge water, and the consequent non-occurrence of any great degree of expansion or contraction in our bilge pump pipe lines, etc., had much to do with the job turning out so satisfactorily.

On arrival at the ship's home port, a new air vessel was fitted; but a good while afterwards, in walking round the repairing shop, I was rather pleased to notice the damaged air vessel where it had been thrown aside still "all sticking together" after, no doubt, much rough handling in foundry and fitting bay.

With regard to suction air vessels, concerning which interesting reference was made by a contributor in the June number of International Marine Engineering, I may say that in a Frühling dredge, on which I did duty for several years, the main pump suction pipes were fitted with suction air vessels. Strictly speaking, they should be called vacuum chambers; our gages sometimes indicated as high as 29 inches of vacuum, this taking place when the "slobber-box" at the "business end" of our suction pipes got buried in the material being dredged.

As dealing with the subject of suction air vessels, the following excerpt from one of the I. C. S. text books may be quoted:

"With a long suction pipe or a pipe having numerous bends and valves, the resistance to the flow of water through it will be considerable, and a great deal of force will be required to start and stop the water in it with each stroke of the pump. In some cases the force required is so great that the pressure of the atmosphere is not sufficient to set the column of water in motion quickly enough to fill the pump chamber as fast as the piston moves. This makes the action of the pump imperfect and causes a severe blow, called the water hammer, when the piston again meets the inflowing water.

"The difficulty can best be remedied by the use of a chamber called a vacuum chamber, or a suction air chamber, attached to the pipe as near the pump as possible.

"In its general form a vacuum chamber resembles an air chamber; but the pressure in it instead of being greater is always less than the atmospheric pressure. When the pump is drawing water, the air in the vacuum chamber expands and forces the water below it into the pump; at the same time the pressure of the atmosphere forces water in through the suction pipe to balance the reduced pressure in the vacuum chamber. The vacuum chamber is again partly filled and the air in it is compressed during the discharge stroke of the pump. It thus acts as a reservoir that receives from the suction pipe a nearly steady supply, which is given up intermittently to the pump.

"For ordinary cases, the vacuum chamber may be made half the size of an air chamber working under the same conditions. A good rule is to make the cubic capacity for a single pump twice that of the displacement of the piston for a single stroke.

"Suction and delivery air chambers should, if possible, be placed at a bend in the pipe and close to the pump, and in such a position as to be in line with the flow of water in the pipe. If placed at right angles to the flow of water their efficiency is somewhat impaired." Mark Nesbit.

A Noise and the Cause

Everybody hates noise when the cause is not understood. A brand-new engine is supposed to run pretty slick, and the one put in the *Brownell* did for about two weeks, when after starting the engine, if it had been lying idle a few hours, a curious knock was developed at each end of the stroke. It was decided that it must be the crosshead brasses, but no amount of adjustment which we could make in them obviated the noise. Then we thought it was in the crankpin brasses, and we took up and slacked off and argued and jawed, but the knock was there. Finally, we took off the cylinder head and expected to find a loose piston nut, but there was "nothing doing." We all got off no end of chuckled-headed remarks about what made the knock, but no one of us could find it. Then I got the idea that the trouble was in the rings, and took the cylinder head off again, pulled out the piston and found nothing the matter with the rings, so I closed it up again.

When I told the chief, he asked me if I had noticed there was no counterbore in the cylinder. I said there was a counterbore. He told me there was not. Then I went to the

oiler who had helped me take the head off and asked him. He said there was a counterbore. Then I thought I had the chief, and made him a bet that there was a counterbore, and the oiler, hearing of this, made a side bet with him. We were both sure. Then we took off the cylinder head, and behold there was no counterbore, and the chief had the laugh on us, and our money.

There happened to be a mate aboard the boat who was almost human, and he knew quite a little about machinery, and he heard of the bet, and came to me and said there was something queer about that bet, as he knew there was a counterbore in the cylinder because he had seen it when I first took the cylinder head off. I promptly made a bet with him, as did the captain and the oiler, and then we opened up the cylinder again, and there was a counterbore. Well, we all talked some. A little while after that there was trouble with the steering gear, and a man came down from the shop that built the engine. When he got the gear in shape he came into the engine room to put in a little extra time to help the boss, and, incidentally, himself. He asked about the engine, and whether I had noticed that the cylinder had a liner in it. I said no, it didn't have a liner, but he said yes it did, as he had turned it up and fitted it. Then I told him about the knock. He scratched his head, and suddenly remembered that he had to get back to the shop. I began thinking about the counterbore, and to make a long story short I found that the liner had been put in because the bore of the cylinder was bad, and to save it a liner was resorted to, and it was pretty thin, and the fit of the cylinder head was very free. But the worst of all was, the chap who fitted it had cut the liner off too short, and, not wanting a "call down," had let it go, and it was not pinned in any way. Now when the cylinder heated up this liner worked loose, going back and forth with the piston and knocking on each end. Of course, when the piston started on the up-stroke it carried the liner with it, and on account of the loose fit of the cylinder head it was able to fetch up at the joint, and when we first opened up the cylinder this condition existed, consequently there was no counterbore, and when on the down-stroke the liner was carried with the piston, of course there was a counterbore.

The builders had to give us a new cylinder, but we are arguing yet about whether those bets shouldn't be declared off and the money returned; but we haven't got that settled yet.

KNOCK.

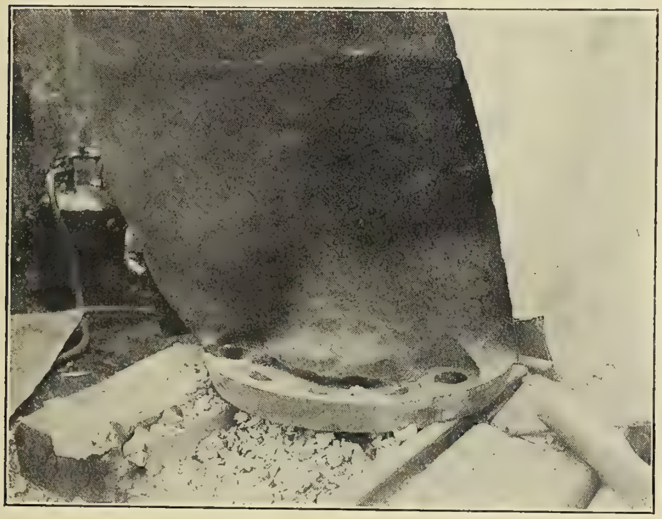


FIG. 1.—FRACTURED BLADE PREPARED FOR WELDING

The Red Star liners *Kroonland* and *Finland* have returned to American registry after flying the Belgian for three years. Both ships were built in 1902.

Unique Repair to a Two-Ton Cast Iron Propeller Blade

The steamship *Pretorian* recently carried away one propeller blade, and on placing the ship in drydock a fracture was found in the flange of another blade, as shown in the photographs.

FIG. 2.—COMPLETED WELD

As there was only one spare blade available it was decided to treat the fractured blade by the oxy-acetylene process and further to reinforce the blade, as shown in the sketch.

The fracture extended along five holes and right through the flange. This was chipped off for a breadth of about 2 inches, and about 200 pounds of high-grade cast iron was fused into this place.

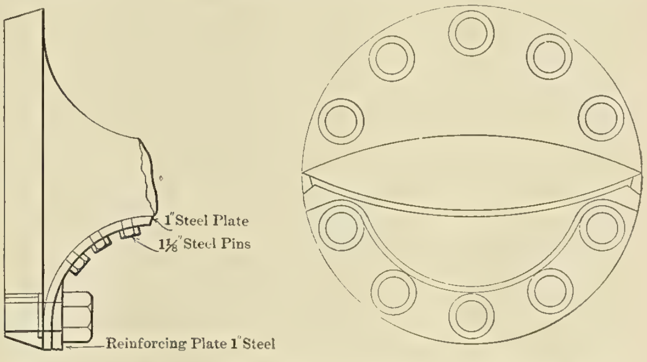


FIG. 3.—SKETCH SHOWING LOCATION OF FRACTURE IN PROPELLER BLADE

The repair was carried out by the Halifax Dry Dock Company, Halifax, N. S. This firm has recently installed an up-to-date oxy-acetylene plant. One job which was accomplished by the plant was the cutting of a 10-inch rudder stock completely through in fifty-two minutes.

The plant, business and good will of the Moran Company, Seattle, Wash., were purchased Dec. 30 by the Seattle Construction & Dry Dock Company. The new company will make some important general improvements to the plant and equipment, and in addition now have under construction a 12,000-ton floating dry dock. This dock will be the largest of its kind on the Pacific Coast, and will give the company ample facilities for docking the largest vessels entering Seattle.

Mr. J. V. Paterson, president and general manager of the Moran Company, holds the same position with the new company.

Review of Important Marine Articles in the Engineering Press

Chinese Training Cruiser Ying Swei.—Messrs. Vickers, Ltd., have recently completed at their Barrow-in-Furness works a training cruiser for the Chinese navy which excels in the comprehensive character of the provisions for the effectual training of officers and men for naval service. It has been the aims of the designers to provide all the fighting capacity possible in a ship of this size, to install as great a variety of guns and machinery as possible for the practical training of the crews, and the ability to easily maintain a high rate of speed. The first of these is obtained by the use of 6-inch, 4-inch, 14-pounder, 3-pounder and 1¼-pounder guns and two torpedo tubes; by extra stores of ammunition of all sizes, and an extra thick protective deck for a cruiser of this size. The second purpose has been carried out by providing both watertube and cylindrical boilers, and, wherever consistent with good efficiency, the use of alternative systems of auxiliary machinery. The third of these aims has been met by the installation of Parsons turbines driving triple screws. The trials have been completed in a satisfactory manner and all conditions of the contract were met. The principal dimensions of the ship are: Length between perpendiculars, 330 feet; breadth, molded, 39 feet 6 inches; depth, molded, 23 feet 9 inches; mean draft, 13 feet; displacement, 2,500 tons; speed, 20 knots. 1,700 words with photographs and drawings.—*Engineering*, December 22.

Description and Trials of United States Torpedo Boat Destroyers Warrington and Mayrant.—By W. B. Robins. Torpedo boat destroyers, Nos. 30 and 31, the *Lewis Warrington* and *John Mayrant,* belong to the first group of oil-burning destroyers of our navy, and have the first installations of Zoelly turbines for naval purposes in this country. Contract for these ships was made Oct. 1, 1908, with the William Cramp & Sons Company, and they were delivered in March and July of 1911. A few of the principal specifications are: Length over all, 293 feet 10½ inches; molded breadth, 26 feet 4½ inches; depth molded to main deck, 16 feet 4¾ inches; draft, 8 feet 4 inches; normal displacement, 742 tons. The main engines consist of two Zoelly compound impulse turbines on two shafts, each having a backing turbine in the after end. Designed horsepower is 13,000, at 650 revolutions per minute, with steam pressure of 250 pounds. The propellers are three-bladed solid manganese bronze wheels machined to true pitch. Diameter is 6 feet 8 inches and pitch 6 feet 2 inhes. Steam is supplied by four White-Forster watertube oil-burning boilers in two fire-rooms and having three smoke stacks. Oil burners are of the Schutte & Köerting type. Complete description and data from trials, which were reported satisfactory, are given in the article, together with photographs. 15,000 words.—*Journal of the American Society of Naval Engineers,* November.

The Cunard Liner Laconia and the Rolling of Ships.—What is called the most important application of the Frahm system of anti-rolling tanks has been installed on the Cunard twin-screw ship *Laconia.* This vessel, a sister ship of the *Franconia,* recently put in commission, is designed for the Boston service. Her general dimensions and specifications are: Length over all, 625 feet; breadth, 72 feet; registered gross tonnage, 18,150 tons; displacement, 25,000 tons. There is carrying capacity for 300 first class, 400 second class and 2,000 third class passengers and 7,000 tons of freight. The chief feature of scientific interest is the anti-rolling tank to prevent the ships rolling when the sea is abeam. A U-shaped 'thwartship tank is fitted and connected along the horizontal line. When waves synchronize with the period of roll of the ship, the water in this tank oscillates with a period equal to the individual period of the ship, but with a difference of phase of 90 degrees. Thus a tendency to counteract the impulse to roll is formed, depending in size upon the volume of the tank and the loading and size of the ship. In this ship the tanks, for there are two of them, are placed forward in the 'thwartship bunkers, where they do not interfere with the arrangement of the ship. They extend the width of the ship and for nine and six-frame spaces, respectively, fore and aft. The connecting passage between the side basins is placed on the double bottom. Each tank has an air valve and piping to pumps for filling and emptying, for use is made of them only when the ship is actually rolling, otherwise they are carried empty. Only sufficient space of the system is used as is necessary to damp the rolling of the vessel, and since the two tanks are entirely independent either one or both may be used. A gyroscope-pendulum is fitted for the measurement and recording of the rolling motions of the ship. This instrument consists of a gyroscope rotated by an electric motor, which remains steadily in the same vertical position. The frame of the instrument rolls with the ship, and its relative position to the wheel is traced on a strip of paper wound up on a roll by a motor. Trials of the apparatus were made, but not at a time when the ship was subject to a heavy swell. It showed clearly a difference in the variety and extent of the ship's rolling when the tanks were in use and when not in use. The results were in general encouraging, but further use will show better in detail what may be expected from their general adoption. 4,000 words and drawings.—*Engineering,* December 15.

Description and Trials United States Torpedo Boat Destroyer Patterson.—By W. B. Robins. Torpedo boat destroyer No. 36, the *Patterson,* was authorized March 3, 1909, contract for building signed June 14 with the William Cramp & Sons Company, and was delivered Oct. 7, 1911, at the navy yard, Philadelphia. Principal dimensions are: Length between perpendiculars, 289 feet; molded breadth, 26 feet 4½ inches; depth, molded, 16 feet 4¾ inches; normal draft, 8 feet 4 inches; displacement, normal, 742 tons; block coefficient, 0.408. Propelling machinery consists of White-Forster oil-burning watertube boilers and Parsons turbines, five of which are arranged on three shafts. Propellers are three-bladed, solid manganese bronze castings, with faces of blades machined to true pitch. Diameter, 5 feet 3 inches; pitch, 4 feet 10.1 inches. There are four boilers arranged in two fire-rooms. Machinery arrangements, aside from main engines, are very much like the *Warrington* and *Mayrant,* reviewed in this number. 3,200 words with tables and plots of vessel's performance.—*Journal of the American Society of Naval Engineers,* November.

Twin-Screw Refrigerated Meat Steamer.—The steamer *El Zarate* has recently been completed by the Greenock & Grangemouth Dockyard Company, Ltd., for the Smithfield & Argentine Meat Company, Ltd. It is to be used for carrying meat down the River Plate to steamers carrying to British ports, and has been designed to the British Corporation specifications for river service. The general dimensions are: Length between perpendiculars 210 feet, 42 feet beam, 11 feet 3 inches molded depth to main deck. A bridge deck is added for 120 feet amidships, which, with the lower holds, gives space for insulated cargo to the amount of 60,000 cubic feet, which accommodates 400 tons deadweight. The hold is divided by five steel bulkheads. All compartments are thoroughly insulated by granulated cork and double thicknesses of tongued and grooved wood. Arrangements for loading are made so that all cargo may be loaded on trolleys without the

rehandling otherwise necessary. The refrigerating plant is sufficiently large so that half may be under repair and the other half keep the cargo at a suitable temperature. The propelling machinery is placed aft, and consists of two sets of compound condensing engines. Extra surface is supplied to insure high vacua at high temperatures of circulating water. Steam is supplied at 140 pounds pressure by two cylindrical multi-tubular boilers. Coal bunkers of large capacity are fitted alongside boilers. On trial the boat maintained a speed of 10.4 knots. 1,350 words, drawings and photograph.—*The Engineer, December* 15.

Marine Jet Propulsion.—By R. Kennedy. A thorough consideration of the forces involved and the most efficient means of employing them. Tells of the tests that were made on the *Water Witch* and why they failed. In this case pumps of very low efficiency were used, and the further mistake was made of stopping the flow of water through the vessel and imparting to it the velocity of the vessel itself. The loss for this is in some cases half the total available for propulsion. In looking for a system that might have a chance to prove its worth in competition with a screw propeller, the pump should show at least 80 percent efficiency. That centrifugals may now be designed even better than that is the author's belief. The one difficulty that is immediately apparent is the large entrance velocity required by the speed of the ship. This may be overcome by making the pump produce increased pressure, working within a Venturi tube, instead of producing increased velocity as is usually done when working in straight pipe. The increased velocity in this case results from the change in pipe size behind the pump and not in the pump itself. Pumps of this type may be arranged in series or multiple or both, depending on what velocity of jet and volume of water the design called for. Contrary to the usual belief, jets of same size as the usual propeller of the screw type are not required. The slower the ship the slower the velocity, and hence the larger volume to be moved. Therefore, the faster the ship the less water per ton of displacement is needed. The water carried within the ship is a serious consideration, and there is at present no way over this. The author thinks a fair test for the only scientific method of jet propulsion is yet untried, and tries to show that such a test would bring a successful solution. 4,800 words.—*The Engineering Review,* November 15.

The German Institution of Naval Architects.—An outline of the papers and discussions at the thirtieth annual meeting of the Schiffbautechnischen Gesellschaft, held at Charlottenburg on the 23d, 24th and 25th of November. This review is given in two instalments, and is of necessity of considerable length. Only those parts of most interest to marine engineers and naval architects will be touched on here, and even those only briefly. An interesting paper was "The Oil Motor in the German Sea Fisheries," by Prof. Romberg, of Charlottenburg. At first light oil motor car engines were used, but these were unsatisfactory. Engines of English make had had some success, but these had bad features. A prize was offered for the best design for an engine for such work, and a fairly satisfactory engine was the result. The main qualities needed were reliability, simplicity and small space requirements. Any complicated engine would suffer from rough treatment in these craft. Discussion on this paper was general and many good suggestions were offered. The next paper was "Studies and Experimental Work for the Design of My Large Oil Motor," by Prof. H. Junkers. The main problems to be solved were, he said, those of the transmission of heat and of the introduction of the charge in as cleanly a manner and at as low a temperature as possible. An important point was to design the combustion chamber as far as possible with unpierced walls. Protracted studies and experiment had led to the construction of an experimental double-piston, two-cycle, horizontal gas engine, which embodied the principles involved. The next step was to adapt this to the conditions of ship work. Plans and particulars were given of the engine being built for a ship for the Hamburg-American Line. The discussion of this paper was, as might be expected from a design so novel, very general, and several features were gone into extensively. Among others questioned were the unusual height of the frame and cylinders, stuffing-boxes, extra number of rods involved, all of which objections were answered by the designer. The next paper referred to the direction of turning of twin screws for best effect in maneuvering a vessel. An example was cited from the experience of the North German Lloyd, and endorsed by the experience of many present, that outward-turning screws were much more favorable to quick and efficient handling of a ship than inward turning. Another paper read was under the title, "Practical Results with Counter Propellers," by Dr. Wagner. The principle upon which this works is that of the water turbine, and when a counter propeller is placed just aft of the usual wheel the efficiency of propulsion is raised from 65 or 75 percent to 85 percent, and by further improvements even 90 percent might be realized. Experiments on small scale have shown this saving to be a real one. The next paper, and the last of importance, was by Herr H. Holzwarth, on "The Gas Turbine." As this paper has been reviewed from the original in our last month's instalment no further comment on it will be given. 12,000 words with photographs.—*The Engineer,* December 1 and 8.

The Suction of Vessels.—A consideration of the causes of the collision between the *Hawke* and *Olympic.* Model tests were made and reported by Mr. D. W. Taylor on the subject of the attraction of passing vessels at the Society of Naval Architects and Marine Engineers in 1909. These results are interesting in that they almost exactly corroborate the Teddington experiments following the recent accident. Although the subject is so large and the experiments made relatively few, some general results are suggested. These are, briefly, that as one ship passes another, when beginning to lap, the bow of the passing ship is attracted to the slower ship and the stern repulsed. When side by side a change takes place, and from that stage on the bow is repulsed and the stern attracted. If the two are in close proximity the rudder apparently does little good, this probably being the case with the *Hawke.* The intensity of these effects vary with the depth of water, size and block coefficients of the ships, width of channel or free water available and the speed of the ships. The case above mentioned was an extreme one, due to the great size of the *Olympic,* her speed and narrow channel in which they attempted to pass. 2,400 words.—*The Engineer,* December 22.

Approximate Stability.—By Arthur R. Liddell, Charlottenburg. Calculations of stability as usually made involve a good deal of laborious and tedious work. The author in this article makes use of approximate curves of righting levers, of which he gives tables and explains the method for obtaining and using. By assuming the 'midship section a rectangle, the righting levers are obtained in terms of the height of the block divided by the half breadth by means of six formulæ. These tables are given for an inclination of 30 and 60 degrees, and a short cut given for getting their values for 90 degrees inclination. From these tables values may be taken for their respective inclinations for any depth of block, and with the initial angle give sufficient points to plot a curve of righting levers. From this point on the process follows the usual course. Other applications than to transverse stability are then described briefly. 2,700 words, diagrams and tables.—*The Engineer,* December 15.

The Conversion of Niclausse into Babcock & Wilcox Boilers on the United States Ships Colorado and Pennsylvania.—By Commander C. N. Offley, U. S. N. This change was made by the Bureau of Steam Engineering on account of the high cost and difficulty of obtaining spare parts for the Niclausse boilers. Eight boilers were changed on each ship and the parts kept as spares for the remaining boilers. The actual work of changing the boilers was not a large part of the whole work, owing to part of the double bottom being renewed at the same time. The removal and replacing of stacks and uptakes was a large part. Article shows how the job was done by drawings and descriptions. 870 words.—*Journal of the American Society of Naval Engineers,* November.

Some Impressions of Continental Marine Diesel Engine Practice—No. I.—Description of a visit to the works of the Carels Frères, and more paricularly of their latest two-cycle marine oil engine developing 1,000 brake-horsepower. This engine is a four-cylinder reversible motor with cylinders 450 millimeters diameter and 560 millimeters stroke, turning at 250 revolutions per minute and weighing about 78 pounds per horsepower complete. Steel castings are used for bedplate and cylinder jackets and in other places. The process of starting is very simple, and is accomplished by use of three small levers. Control of speed after starting is accomplished by varying the delivery of fuel pumps. An improved engine has been already designed, and while the drawings were examined by the author no comments are printed. It is expected that many objectionable features in this older engine will be removed in the new. 2,450 words and photograph of the engine.—*The Engineer,* December 8.

Some Impressions of Continental Marine Diesel Engine Practice—No. II.—This instalment deals with what was seen at the Maschinenfabrik Augsburg-Nürnberg plant. Although this company has been building oil engines for twelve years it turned its attention to marine reversible engines only three years ago. Of single-acting engines two types are being made—heavy and light. The former are for ordinary commercial purposes, and weigh about 110 pounds per brake-horsepower, including all auxiliaries and thrust block. They are made in eight sizes, from 150 to 2,000 brake-horsepower, running from 300 down to 185 revolutions per minute for the two extremes. The standard engine of this type is six-cylinder and has no fly-wheel. The lightweight engines are designed for naval purposes, and are offered in ten sizes, running from 550 to 300 revolutions per minute. The total weight for this design is from 37 to 50 pounds per brake-horsepower, varying inversely with the size. The M. A. N. engines show very well the simplicity of the two-cycle type, and are provided with reversing and handling gear of unusually simple and effective design. One notable engine was shown of the double-acting type, which was of 850-1,000 horsepower, working at about 130 revolutions per minute. It had three cylinders of 18.9 inches diameter and 25.6 inches stroke. Arrangement has been made whereby for slower running the oil to the lower half of the cylinders may be cut off and the engine run single-acting. After a detailed account of the mechanism of the engines built by this firm the manner of reversing the two-cycle engine is explained in detail. 3,000 words and photographs.—*The Engineer,* December 15.

Some Impressions of Continental Marine Diesel Engine Practice—No. III.—This paper deals exclusively with a visit to the works of the Sulzer Bros. at Winterthur. The most space is given to the description of this firm's latest type of six-cylinder marine engine, followed by description of an installation in the twin-screw oil ship *Romagna.* The whole article is well illustrated with photographs and drawings, and well shows what has been accomplished by this one firm in a new line of marine engineering. The general impression received at the works is that the largest jobs are handled there as a matter of everyday occurrence. Surely a great variety of work is turned out. One engine seen was a single-cylinder motor designed to give 2,000 horsepower at the brake, and at the same time there was being built a three-cylinder engine for 35 horsepower at 450 revolutions. The latest Sulzer six-cylinder motor is two-cycle, and gives 300 brake-horsepower at 500 revolutions per minute. It has scavenging and compressed air pumps at the forward end of the crankshaft. The scavenging air valve is placed at the bottom of the cylinder, operated by a tappet without the intervention of a rocker. Repeated experiment has shown that this placing of the valve is as conducive to efficiency as the usual one in the head of the cylinder. The cams operating the fuel and compressed air in the head of the cylinder are run in oil, greatly reducing the noise. Trunk pistons are used and the bottom of the engine is enclosed. The bedplate is of bronze, while aluminum is used to some extent for doors, etc. The Italian mail boat *Romagna* is 175 feet long, 25 feet of beam and 12.6 feet in depth, with a displacement of 1,000 tons. She has two 800-horsepower motors, which take up a very small space in the hull. On trial, it is said, she did 12.4 knots, and thorough maneuvering tests were satisfactorily carried out. It is reported that in actual service the governor kept the engines under control in heavy seas. 3,000 words.—*The Engineer,* December 22.

Superheated Steam at Sea.—By P. C. Ashford. A review of the situation in marine engineering of the case of the superheater. Although the resulting economy from the use of superheaters has been known for fifty years, their use was not extensively adopted because of the difficulties attendant upon their practical operation. Thus at first there was difficulty in the design of a suitable superheater. Afterward, difficulties with oil in feed water, salt leaking through condensers into the feed and other minor troubles caused owners and builders to overlook the economy to be obtained. Within the last few years these difficulties have been overcome, and the future of the superheater for marine service is bright. Many small installations are in operation as well as some as large as 20,000 horsepower in the German and United States navies. The extensive introduction of turbines revived interest in superheaters, for though a smaller economy is given when used with turbines the troubles are practically nil. The Schmidt type is one commonly used with Scotch boilers and the Babcock & Wilcox with watertube boilers. The article gives tables of data showing the economy obtained from various degrees of superheat with both types, together with numerous illustrations of them in boilers of different kinds. 2,600 words.—*Cassier's Magazine,* November.

A New Horsepower Calculator.—By Commander U. T. Holmes, U. S. N. A useful instrument for shipboard where many horsepower calculations must be made. Based on the expressions $H.\ P. = \frac{P \times R}{k}$, or $H.\ P. \times k = P \times R$, and making use of logarithmic scales on the principle of the slide rule. The instrument is adaptable to different engines by changing the position of the rule on which is marked the value of the k. Scales for converting mean effective pressures into equivalent mean pressures, and for showing values of moments in the Denny-Johnson torsion-meter shaft corresponding to angular deflections of the shaft as measured, are shown on the same board. The device was arranged by Lieutenant-Commander L. F. James, U. S. N., and it has become a part of the equipment of the engineering laboratory at the Naval Academy as well as of the engine rooms afloat. 1,800 words with several illustrations.—*Journal of the American Society of Naval Engineers,* November.

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As shown on another page of this issue, nearly every maritime country in the world has shown a remarkable increase in the amount of shipbuilding and marine engineering carried out in 1911. Not only have the records of the leading shipbuilding centers been exceptional, but the rate of increase in the smaller maritime nations has, in many cases, been abnormal. Naval work, of course, in many cases predominated; but, aside from that, the remarkable records made were due principally to the widespread expansion of over-sea trade and the consequent upbuilding of the world's merchant marine. At the present time reports from Lloyd's show that the figurès for the tonnage under construction in the United Kingdom for the last quarter are the highest ever recorded by the society, being 5 percent greater than the preceding quarter and 30 percent greater than that for the corresponding period last year. With such prospects and with the forthcoming readjustment of maritime commerce by the opening of the Panama Canal, shipbuilding and its allied industries cannot fail to maintain an unprecedented era of activity.

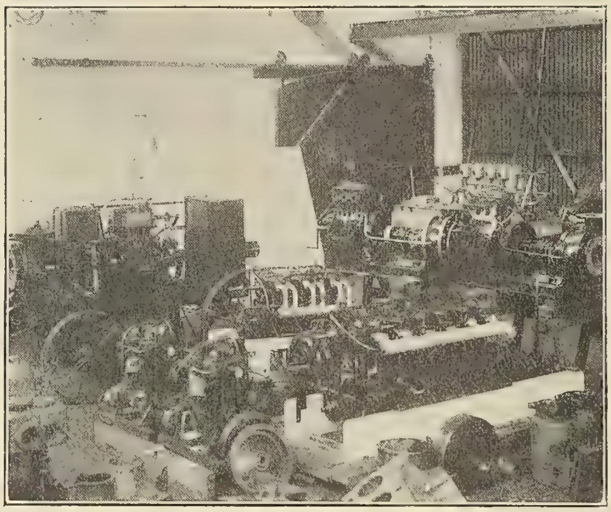
The McAllister plan for assessing tolls on vessels making use of the Panama Canal seems to have been very favorably received, not only by members of the Congressional committee investigating the subject, but by many others who have given thought to the question of tolls. This plan, as laid before the committee by Captain C. A. McAllister, engineer-in-chief of the Revenue Cutter Service, proposes to do away entirely with the usual plan of assessing tolls on the net tonnage of all vessels with the various exceptions and conditions necessitated by the different types of vessels. It proposes to have every ship entering the canal measured, as to length, beam and draft at the waterline, so as to secure its so-called block displacement. It would take but a short time to make these measurements and to figure exactly the number of cubic feet in the block determined by these dimensions. The toll is to be a fixed amount per cubic foot of block displacement. The possibility of there being some injustice to a fast ship of fine lines with a comparatively small carrying capacity, and the rules being particularly favorable to steamers of the tramp type, is believed to be overbalanced because of the much higher freight rates the ship of finer lines would charge. In whatever way the question may be viewed, the unfairness which accompanies the usual methods of assessing canal tolls is obviated, and the proposed plan is commendable for its simplicity.

One of the innovations in marine engineering which has made a rapid advance in recent years is the use of the small steam turbine for driving auxiliaries. The initial steps in this direction were, of course, limited, and it required time to work out the adjustments necessary to adapt the machine to its peculiar requirements on board ship. The many years which had been spent in the perfection of small reciprocating engines for this service left a small margin of improvement for the turbine to show its superiority. The adaptation of the turbine drive to ship auxiliaries, however, was more closely related to similar installations on shore than, for instance, was the use of the turbine in large units for ship propulsion, and, consequently, the experience gained from the wide use of the turbine-driven auxiliaries on shore did much to develop this type of turbine for marine work. The result has been that small steam turbines are now being used, to a great extent, on both merchant and naval vessels for driving electric generating sets, forced draft blowers, rotary air pumps and air compressors. A more recent use of the turbine, and one which promises to be of considerable advantage, is the develment of turbo circulating and feed pumps. Installations of such character frequently require the use of machines developing several hundred horsepower at the brake. To accomplish this, and to take the place of economical reciprocating engines, it is necessary that the small turbine show a good performance in the question of steam consumption. It is gratifying to note that good results in this direction are now obtainable.

Improved Engineering Specialties for the Marine Field

Brooke Gasolene (Petrol) Engine

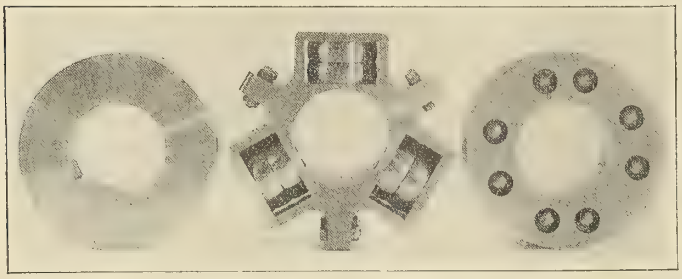
The variety of uses for which the Brooke internal-combustion engines are made is shown in the accompanying illustration, a view which was taken in the corner of the finishing shop. The trolley shown on the left is fitted with a 12-horsepower Brooke motor, one end of which drives a centrifugal pump and the other end a belt pulley. Beyond this apparatus



are two 12-horsepower centrifugal pumping sets and a 45-horsepower motor. In the foreground is a 65-horsepower marine motor, a 4-horsepower pumping set and a 25-horsepower six-cylinder motor, also a 4-horsepower electric lighting set. These equipments are manufactured by J. W. Brooke & Company, Ltd., Lowestoft, and they are all destined for shipment to foreign countries.

Planet Thrust Bearings

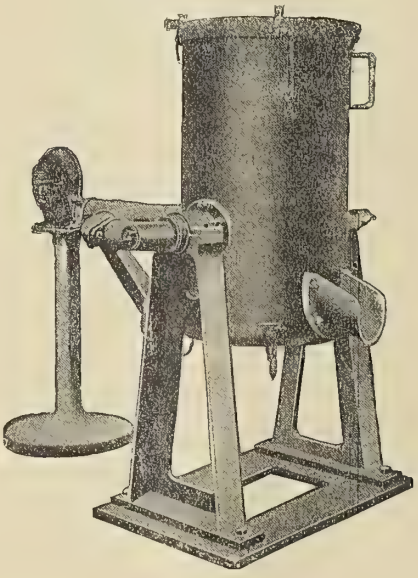
Roller or ball bearings for taking end thrust have proved successful, but there are some features in connection with the design of the bearing which have to be considered. It is impossible to produce a mechancial coupling in a single ball where the load is transmitted through the ball to two plane surfaces. In the thrust bearing made by the Planet Engineer-



ing Company, New York City, the three-point support avoids intermediate stresses due to inequality of size or the presence of grit. Since the load-carrying capacity of a ball increases as the square of the diameter, the design of the Planet bearing, it is claimed, allows a larger diameter than any other type of ball or roller bearing. The details of design concerning the support and mounting or housing of the bearing surfaces are matters which can be determined by the designer of the apparatus, and the manufacture of such parts is within the scope of ordinary machine shop practice. But it is not practical for the ordinary manufacturer to make steel of the requisite quality, nor are many machine shops equipped with precision tools to grind the steel to the accurate dimensions required. These are matters which can be taken care of by the product of the Planet Engineering Company, and the details can be worked out for a variety of uses.

Green's Emergency Cupola

The furnace illustrated was designed for making castings which are urgently needed for breakdown work or for test mixtures or for pouring castings which have missed or cannot wait for the next blow from the ordinary cupola. The need of such an auxiliary in ordinary foundry work is apparent, but the casting must be done quickly and satisfactorily. In this furnace the blast is admitted through two hollow trunnions which form the tuyeres. There are two suitable bend pipes fitted with sight holes, so arranged that any slag which may find its way into them may be removed readily



without causing a choking up of the blast pipes. To the two bend pipes is coupled a suitable Y-shaped pipe, which connects the fan to the furnace and which is fitted with a suitable blast gate. The blast fan is mounted as shown in the illustration, and requires about one-half horsepower for operation. The furnace is fitted with a drop bottom and two pouring spouts, the top spout being available in event of the bottom one becoming choked with chilled iron or slag. The lining of the furnace is of ganister. When in operation molten metal pours out the spout in from eight to ten minutes after setting on the blast, and it is reported that 20 cwt. heats are melted daily, and sometimes 40 cwt. heats, with satisfactory results. George Green & Company, Keighley, are the manufacturers of the cupola.

A New Propeller Material

Monel metal, which is a "natural alloy" that is regarded as a successful substitute for steel and bronze, has recently been cast in pieces weighing as much as 25,000 pounds. Most of these large castings have been for propellers that are furnished to the United States Government in accordance with standard specifications for this metal. The demand for wheels

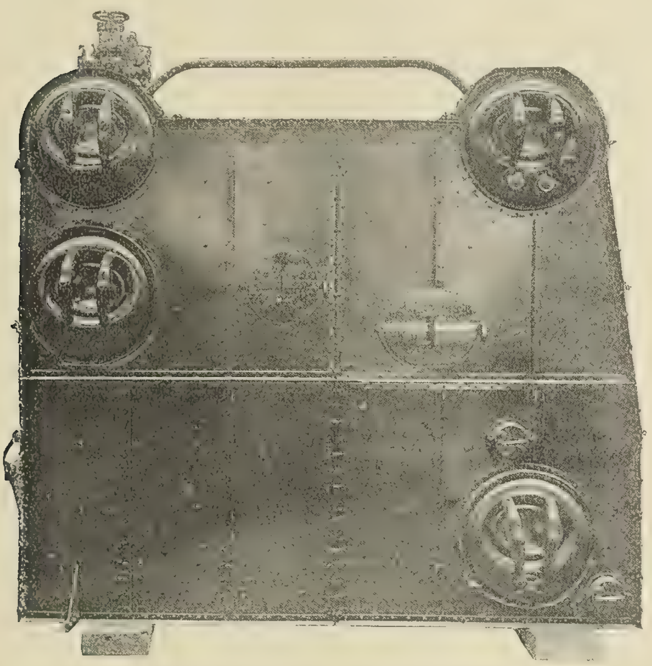
of this metal is increasing, which is indicative that it possesses unusual qualities that make it extremely suitable for this purpose.

One of the most prominent of the naval vessels that has been equipped with propellers of this metal is the Argentine Republic's huge battleship *Rivadavia* recently launched at the Fore River shipyard. It has three propellers, and all are made of Monel metal and three-bladed, each casting weighing 16,000 pounds.

Two spare wheels of 18,000 pounds each have also been made for the *North Dakota,* while four propellers, each weighing 8,000 pounds, have been cast for the *Florida.* These last are of the three-bladed design, which is preferred for high-speed vessels, though when the diameter is unduly restricted four or more are used.

Many torpedo boat destroyers are now fitted with Monel metal propellers. The more important of those propelled by a three-bladed design weighing 2,000 pounds each are the *Terry, Roe, Sterrell, Perkins, Walke* and *Fanning.*

Heretofore propellers have been made largely of various kinds of bronze, particularly manganese bronze; the qualities that have made manganese bronze suitable for this use are its



EXTERIOR OF BADENHAUSEN MARINE BOILER, SHOWING THE CASING AND MANHOLES

ability to resist shock and its resistance to salt water corrosion; but with the rapid development of the marine turbine the demand for a propeller material that would stand even better the severe shocks of high-speed service has become manifest. With the idea in view of using Monel metal as a substitute for bronze various tests were made on propellers cast of this material. The results were surprising, and at first were thought to be due to increased tensile strength, yield point and the retention of its high polish without corrosion or pitting, for Monel metal takes a finish like pure nickel. The most probable of these appeared to be the last, as the increased tensile strength over that of manganese bronze would only indicate an increase of the factor of safety and resistance to shock rather than resistance to stresses within the elastic limit. Careful experiments with a testing machine on a large number of samples demonstrated that the remarkable results were due to the modulus of elasticity. Manganese bronze has a modulus of elasticity of 13,000,000; Monel metal, 22,000,000 to 23,000,000, and steel 28,000,000 to 32,000,000. All metals, of course, distort inside the elastic limit and recover again when the stresses are removed, but it will be noted that the distortion with Monel metal is less than with manganese bronze. With distortions come changes of pitch and consequent losses of efficiency.

From a practical standpoint the following tests, made in duplicate, from test pieces cut from one of the blades for one of the 16,000-pound propellers for the *Rivadavia,* are interesting as showing both the strength and uniformity of this new metal:

TESTS ON MONEL METAL PROPELLERS

Laboratory of Wm. Sellers, Inc., Philadelphia, Pa.

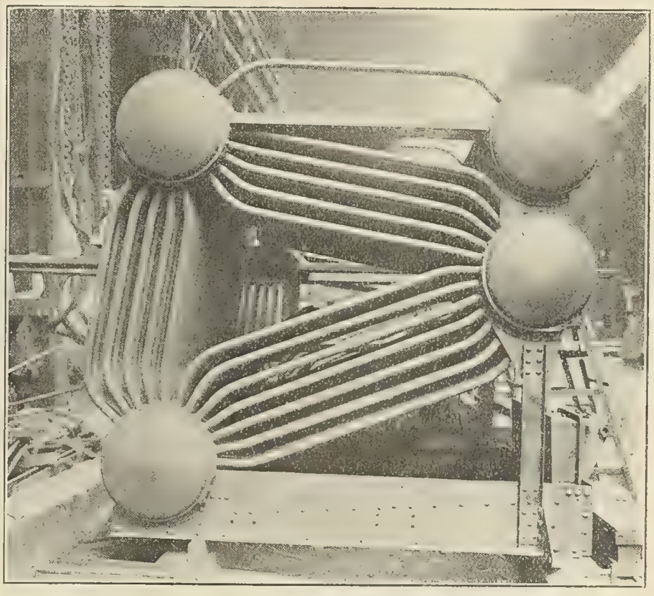
	Pounds Per Square Inch.		Elongation
	Yield Point.	Tensile Strength.	in 2 ins.
First blade	38,806	82,580	45%
Second blade	35,820	81,570	45
Third blade	37,500	86,500	45

Laboratory of the Orford Copper Company, Bayonne, N. J.

	Pounds Per Square Inch.		Elongation
	Yield Point.	Tensile Strength.	in 2 ins.
First blade	37,500	82,500	45%
Second blade	37,500	82,250	44
Third blade	37,250	83,500	33

The Badenhausen Watertube Marine Boiler

An all-steel watertube marine boiler, with no hand-hole plates, flat surfaces, stay-bolts, cast metal or screwed joints, is manufactured by the Badenhausen Boiler Company, 90 West street, New York City. The boilers are built in large units, so designed as to occupy minimum space. The arrangement consists of three or four drums connected by tubes. The large mud-drum, full of water at the point where water is most



BADENHAUSEN MARINE WATERTUBE BOILER

needed, means that the steaming tubes are well supplied with water under all conditions, so that the boiler can be forced to an exceptional degree. Boilers of this type, it is claimed, have been operated at 250 percent of normal rating at long periods of time. Every tube discharges its full opening directly into the steam drum, thus delivering the mixed steam and water with the least possible disturbance. Access to the interior of the boiler is given through the drum man-holes. No hand-holes, plates, dogs, nuts or gaskets are used, so that the possibilities of leakage and failures are reduced to a minimum. The tubes are slightly bent, so as to enter the drums radially, and are cleaned by means of mechanical tube cleaners. The outside of the tubes can be cleaned from the front of the

boiler by means of a steam lance. The construction of the boiler admits replacing the tubes from the front of the boiler as well as cleaning and blowing them from the same position. The baffling can also be done in a simple manner, as no special shapes are required.

Advances in steam engineering have now placed boiler design under new conditions, since it has been found that well-designed boilers can be operated economically at at least double rating, and even more, and that large units can be used to better advantage than a great number of small units. The Badenhausen boiler has been designed to meet these conditions.

Anchor Bushes

Air pump and other valves, whether hard or flexible, have frequently to be discarded before the body of the valve is worn out, owing to the enlargement of the central hole, Fig. 1, which is brought about by the wear caused by the vertical

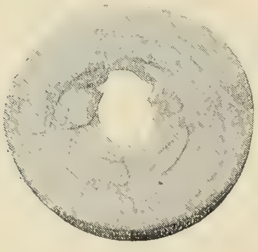


FIG. 1

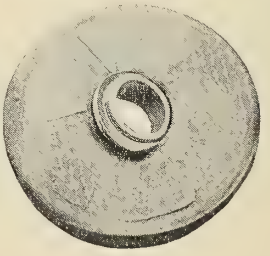


FIG. 2

movement on the stud. Remedies for this difficulty which have frequently been used have been bushing the valves and vulcanizing the bushes into the valves, but continued use has resulted in subsequent breakdowns, as shown in Fig. 2. A new

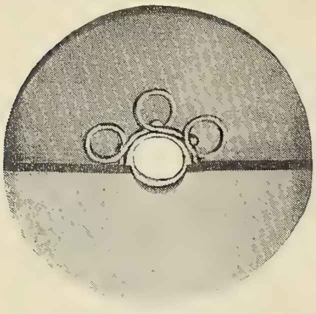


FIG. 3

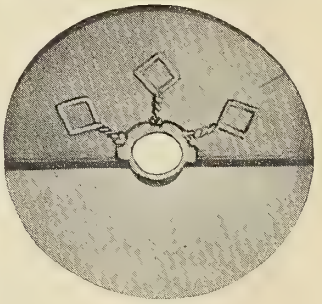


FIG. 4

method of overcoming this difficulty has been devised by the Dermatine Company, Ltd., 93 Neate street, London, S. E., in the development of what are called "anchor" bushes. As shown in Figs. 3 and 4, the bush is embedded and vulcanized into the valve in such a manner as to prevent loosening. In the case of anchor bushes for flexible valves, Fig. 3, the arms, being hinged, allow the valve to "saucer" readily, and with hard valves, Fig. 3, there is just sufficient flexibility with the wear loop to prevent the beat on the seating and to guard from cracking the valve.

Marine Steam Turbines, by Dr. G. Bauer and O. Lasche, assisted by E. Ludwig and H. Vogel, and translated from the German and edited by M. G. S. Swallow, which was reviewed on page 42 of our January issue, is being published in the United States by the Norman W. Henley Publishing Company, 132 Nassau street, New York city. The price of the American edition is $3.50 net.

Technical Publications

Thermodynamics of the Steam Turbine. By Professor C. H. Peabody. Size, 6 by 9 inches. Pages, 282. Illustrations, 103. New York, 1911: John Wiley & Sons. Price, $3.00 net (12/6).

Most of the books on steam turbines which have been published, and a good many of them have been published in the last few years, have been largely of a descriptive nature, describing briefly the principles of action and the details of construction of the various types of turbines. Those who have attempted to study the subject with a view to designing, constructing or operating turbines have usually been at a loss to find any accurate treatise on the thermodynamics of this type of engine. For this reason, Professor Peabody's book stands practically alone, in that it is devoted entirely to the application of thermodynamics to steam turbines. The book was written particularly for the use of students in technical schools, and the author assumes that those undertaking such work will have a good preparation in general thermodynamics. A brief resumé is given in the first chapter of the properties and computations for steam, and then the study of the computations involved in steam turbine design are taken up in complete form. The book includes chapters on steam nozzles, jets and vanes, simple impulse turbines, pressure compounding, velocity compounding, pressure and velocity compounding, reaction turbines, accessories, effect of conditions, and marine steam turbines. The author states that the methods given are in general those accepted by steam turbine designers, but that certain methods have been devised by the writer either to make the methods more complete or to provide more rapid and precise determinations of conditions and proportions. The subject is treated very clearly, and in such a manner that little other instruction is necessary for the reader to thoroughly understand the subject.

Fore and Aft. The story of the fore and aft rig from the earliest times to the present day. By E. Kreble Chatterton. Size, 9¾ inches by 7 inches. Pages, 347. London: Seeley Service & Company. Price, 16s.

Mr. Chatterton has followed up his "Sailing Ships and Their Story" with the present well-illustrated and popularly instructive volume dealing with the evolution of the fore and aft rig. The present work contains only a few pages less than the bulky volume which dealt with all types of sailing vessels. The author is a thoroughly experienced yachtsman and adores his subject; in an interesting preface he says that his "joy and delight when voyaging in any kind of sailing vessel is intensified a thousandfold when he knows her ancestry." His aim in the present volume is to follow in detail the history and development of fore and afters, and for this purpose he has investigated the subject very fully. He traces, step by step, how different countries and different localities have adopted this rig to suit their special requirements. As the fore and aft craft is the only type of sailing vessel which is increasing, the present work is likely to be of permanent value to men in any way interested in yachts. There are altogether 130 illustrations, the arrangement of the volume is particularly attractive, and is a credit to the publishers.

Gas Engine Theory and Design. By A. C. Mehrtens, M. E. Size, 5¼ by 8 inches. Pages, 251. Illustrations, over 200. New York, 1909: John Wiley & Sons. Price, $2.50.

To present the theory and the "why" of many things connected with gas engines in such form that students, draftsmen and engineers, and also men who operate gas engines of any kind, can understand them and apply their knowledge, was the aim of the author of this book, who prepared it principally

for use as a textbook in an engineering school. In such a small volume it is, of course, impossible to give a complete discussion of the thermodynamics of the gas engine, but as far as space allows the actual conditions of theory and design are given. Readers of this book will find of particular value the part which takes up the design and dimensions of parts of gas engines, which contains information which it is usually difficult to obtain except from practical experience.

Shipyard Practice as Applied to Warship Construction. By W. J. McDermaid. Size, 6 by 9 inches. Pages, 328. Numerous illustrations. London and New York, 1911: Longmans, Green & Company. Price, 12/6 net.

This work embraces a course of lectures given by the author to cadets of naval construction at the Royal Naval College. They are of a very practical nature, and, with the very complete illustrations, give the reader a splendid opportunity to learn how the actual work of construction of warships is carried out in a shipyard. This is the kind of information which is usually acquired only by actual work in a shipyard, and therefore a practical treatise of this kind is a most convenient source of information for the student of naval architecture and shipbuilding.

Power Plant Testing. By James Ambrose Moyer. Size, 6 by 9 inches. Pages, 422. Illustrations, 271. New York, 1911: McGraw-Hill Book Company. Price, $4.00 net.

One of the most important fields of work for an engineer is the testing of power plants, but the study of this work has usually been confined to laboratory work in technical schools. On account of the value of the work a volume containing a careful treatise of the methods of testing various kinds of machinery is of considerable value. The ability to make careful and reliable tests from which accurate data can be obtained for guaranteeing the performance of various kinds of machinery is one of the most valuable assets of an engineer. The work is of very broad scope, however, and accurate information regarding the measurement of different factors is necessary. Measurement of pressure, temperature, area, power, flow of fluids, calorific value of fuels, gases, etc., involve different procedures and the use of different instruments. These are all treated by the author in such a way as to be useful not only to students but also to practical men, so that those who have not had the privilege of professional training can become familiar with the up-to-date methods of testing.

Electrical Propulsion of Ships. By H. M. Hobart. Size, 5½ by 8½ inches. Pages, 167. Illustrations, 43. London, 1911: Harper & Bros. Price, 5/ net.

Electric propulsion, while strongly advocated, has as yet seldom been adopted except in small powers. The possible difficulties of its use have so far outweighed its many evident advantages. A great deal of information has been published on this subject in current engineering literature and comprehensive papers have been presented before engineering societies. Bids have been made for large installations for both naval and merchant marine work, therefore the interest in this subject warrants the publication of a work which is largely a condensed statement of the various articles which have been published on this subject. While the author of this book, we understand, is engaged in electrical engineering work, he has not attempted to present any particular work of his own, but has obtained his information and conclusions from the available material on this subject. The book has been written in a very instructive and readable manner, and should be of much interest to those engineers who are not very familiar with electrical work and would like to know what the main features and possibilities of this method of propulsion are.

Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,003,063. SUBMARINE OR SUBMERGIBLE BOAT. EDWARD LASIUS PEACOCK, OF BRIDGEPORT, CONN.

Claim 1.—A submarine or submergible boat, having a deck provided with an adjustable section that is adapted for adjustment whereby one end of said section may be elevated or lowered out of horizontal alinement with the fixed section of the deck to present inclined surfaces to the water when the boat is operating submerged. Fourteen claims.

1,003,364. BOAT CONSTRUCTION. FREDERICK B. LANGSTON, OF NEW YORK, N. Y.

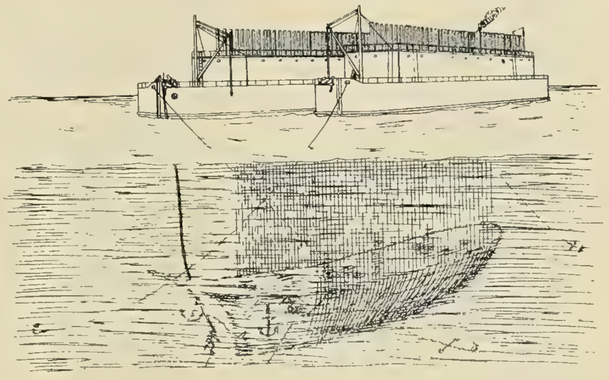
Claim 1.—In a boat construction, a hull having an under supporting surface; a plurality of parallel, fore-extending side plates projecting beneath said supporting surface; an upwardly inclined fore skidding member with its rear lower edge depressed below said supporting surface and cross-connecting said side plates; and an aft skidding member with its under surface inclined aftwardly and downwardly from said supporting surface and cross-connecting said side plates, every cross section through the under surfaces of both said skidding members being a horizontal straight line. Seven claims.

1,004,552. SUBMARINE SALVAGE APPARATUS. HARRY LIVINGSTON BOWDOIN, OF NEW YORK, N. Y.

Claim 1.—A submarine salvage apparatus, consisting of a strongly-built chamber, means for providing a circulation of air for breathing purposes in said chamber, means for raising and lowering the apparatus, ball and socket universal bearings in the walls of said chamber, tools operated through the bearings from the inside, a cable for supplying electric light and power within said chamber, magnetic arms attached to said chamber, and suitable means of propulsion through the water and on the bottom. Three claims.

1,005,408. DEVICE FOR RAISING SUNKEN VESSELS. CHAS. H. BROWN, OF LONGBEACH, CAL.

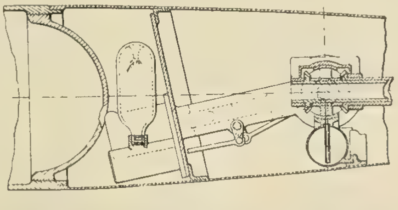
Claim 1.—A barge of he class described having cable ways formed therein and disposed at intervals along the length of the barge, cable



receiving trunks extending in an inclined direction from said cable ways and carriers extending between said cable ways, and trucks adapted to carry cables between the same. Seven claims.

1,005,647. MEANS FOR THE PROPULSION OF AUTOMOBILE TORPEDOES. ALBERT EDWARD JONES, OF FIUME, AUSTRIA-HUNGARY, ASSIGNOR TO MESSRS. WHITEHEAD & CO., OF FIUME, AUSTRIA-HUNGARY, A CORPORATION.

Claim 2.—A torpedo having a propeller shaft provided with a propeller, a motor, a driving mechanism connecting the motor to the shaft,



and an oil reservoir symmetrically disposed at each side of and below the propeller shaft and having a feed pipe leading to the said mechanism. Ten claims.

1,006,044. ELEVATOR FOR MARINE VESSELS. HARRY BARLOW, OF SEATTLE, WASH.

Claim 1.—In an apparatus of the class described, the combination with the hull of a vessel provided with an upper and lower deck, the upper of said decks having an opening therein, of a vertically movable platform formed of a series of planks and angle bars, guide pulleys located

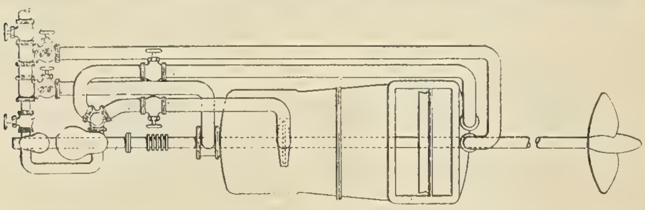
below the lower deck, supporting posts, guide pulleys upon said posts, cables connected to said platform and traveling over said guide pulleys, and means whereby said cables are actuated for hoisting and lowering said platform, certain of the beams of the lower deck being provided with notches for the reception of said angle bars when the platform is lowered against the lower deck. Two claims.

1,006,212. TORPEDO-TUBE CAP. HARRY HERTZBERG AND MAURICE J. WOHL, OF BROOKLYN, N. Y., ASSIGNORS TO ABBOT A. LOW, OF HORSESHOE, N. Y., AND MAURICE J. WOHL AND HARRY HERTZBERG, OF BROOKLYN, N. Y., TRUSTEES.

Claim.—In combination with a submarine vessel having an opening at one end thereof, of a torpedo tube having its mouth filling said opening, a hinged cap having a thickened central portion and provided with a gear attached thereto outside of said vessel and arranged to cover said opening and the mouth of said torpedo tube, the exterior surface of said cap being formed to conform to the exterior surface of the vessel, the said surfaces together providing a continuous uniform exterior surface for the vessel when said cap is closed, a shaft extending from the outside to the inside of said vessel and provided with a worm at the outer end thereof meshing with said gear, and a means positioned within said vessel for rotating said shaft and worm to operate said cap.

1,006,674. MARINE PROPULSION. CHARLES ALGERNON PARSONS, OF NEWCASTL-UPON-TYNE, AND STANLEY SMITH COOK, OF WALLSEND, ENGLAND; SAID COOK ASSIGNOR TO SAID PARSONS.

Claim 1.—In combination in a marine turbine installation, means connecting two portions of a shaft, said means producing a thrust which



is proportional to the torque transmitted between the shaft portions and which acts to balance the propeller thrust.

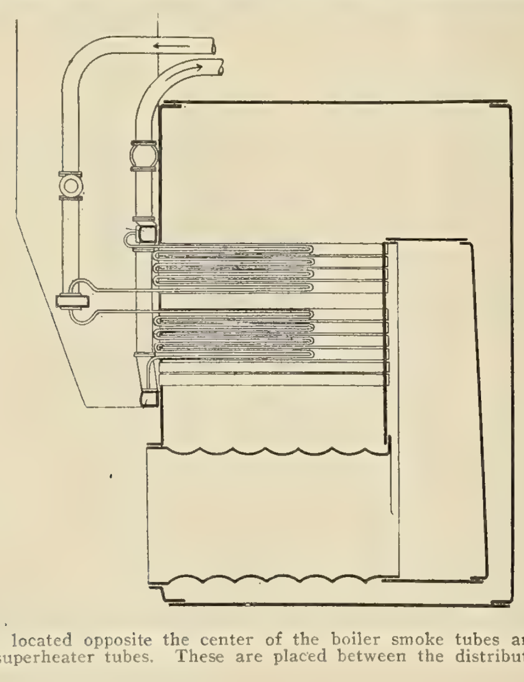
1,006,380. VENTILATING APPARATUS FOR SUBMARINE VESELS. HARRY HERTZBERG, OF NEW YORK, ABBOT A. LOW, OF HORSESHOE, AND MAURICE J. WOHL, OF NEW YORK, N. Y.; SAID HERTZBERG, LOW, AND WOHL ASSIGNORS TO THEMSELVES, TRUSTEES.

Claim.—In a submarine vessel, in combination, a conning tower, a ventilating device positioned in front of said conning tower, a ventilating device positioned in the rear of said conning tower, said ventilating devices each comprising a tube extending upwardly from the interior to the exterior of the vessel, the tubes of each device having the upper end flaring and extending in opposite directions toward the ends of the vessel, and cup-shaped receptacles inclosing the lower ends of said tubes into which the air is received and also any water which may enter the tubes, said cup-shaped receptacles being provided with air outlets above the lower ends of said tubes and also with means for removing the water therefrom.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C. London.

12,633. STEAM SUPERHEATER FOR MARINE BOILERS. A. O. P. FREDERIKSEN, COPENHAGEN.

This superheater is characterized by a box, for distributing saturated



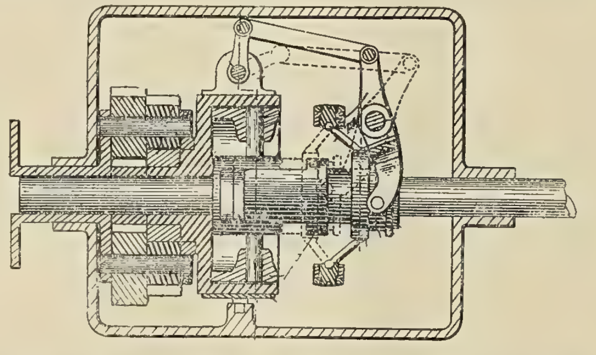
steam, located opposite the center of the boiler smoke tubes and fitted with superheater tubes. These are placed between the distributing box and steam-collecting boxes, located along the upper and lower edges of the smoke tubes.

7,432. TUBES, MASTS, ETC. A. SIEWERT, BERLIN.

There has lately arisen a demand for tubes of increased diameter and supporting power for telescoping masts, etc. This invention relates to a tube of polygonal cross section, and the novel construction and arrangement consists in that it is composed of separate rods or strips, one of which engages the next adjacent by means of projections which pass through slots in the latter.

13,419. MARINE CLUTCH AND REVERSING GEARING. C. S. HOOK, TORONTO.

The engine is coupled to a sleeve loose on the propeller shaft and carrying the reversing pinions. A drum like the sleeve also rotates on the shaft, when reversing. In running forward, the drum is locked to the shaft by shoes which engage its rim from within, being thrust apart by



cams operated by toggles and a slide on the shaft. The lever which operates the slide also works links and a crank which, in another position when the shoes are withdrawn, clasps a band tightly around the outside of the drum to hold it so that the pinions are caused to rotate and so reversely turn the propeller shaft. This arrangement gives a positive forward drive.

14,216. HYDROPLANE BOATS. H. M. VAN WEEDE, VIENNA.

This invention is characterized by forming the hull of an arched shell open at bow and stern with the crown sloping downward from stem to stern, so that air taken in at the larger front end of the arch will be compressed as the boat moves forward because of the reduction in the cross sectional area of the arch towards the rear, with the result that the boat will skim along the surface of the water. Horizontal fins are provided for controlling the depression or trim of the boat whilst air tubes are used to float it.

19,210. INDICATING VARIATIONS IN DISPLACEMENT. S. S. STRONG, LIVERPOOL, FROM T. M. MACFARLANE AND J. R. DOUGLAS, ON THE HIGH SEAS.

In this apparatus a tube contains a float and is placed amidships and in communication with the sea. The float is connected by a cord to a slipper on guide, and which is attached to a band connecting it with

the counterweight of the indicator—a vertical scale and slipper guide and slipper. Thus the motoon of the first slipper is magnified at the second slipper.

21,948. SUBMARINE MINES. G. E. ELIA, PARIS, THROUGH VICKERS, SONS & MAXIM, LTD., LONDON.

The mechanism for exploding the mine is attached to a loose rope which floats in the tideway beneath the surface so that a ship's propeller may become entangled in it and so explode the charge, also submerged and in the form of a boom. This boom is maintained at a constant depth by means of a hydroplane fast to an anchor cable. Two such booms are connected by a cross rope so that the bow of a ship may draw them to her side, when the tension on the cross rope will explode the booms should the trailing ropes fail to become entangled. In a modification the anchor contains the explosive and the firing mechanism, and is likewise drawn to the ship's side before detonation.

International Marine Engineering

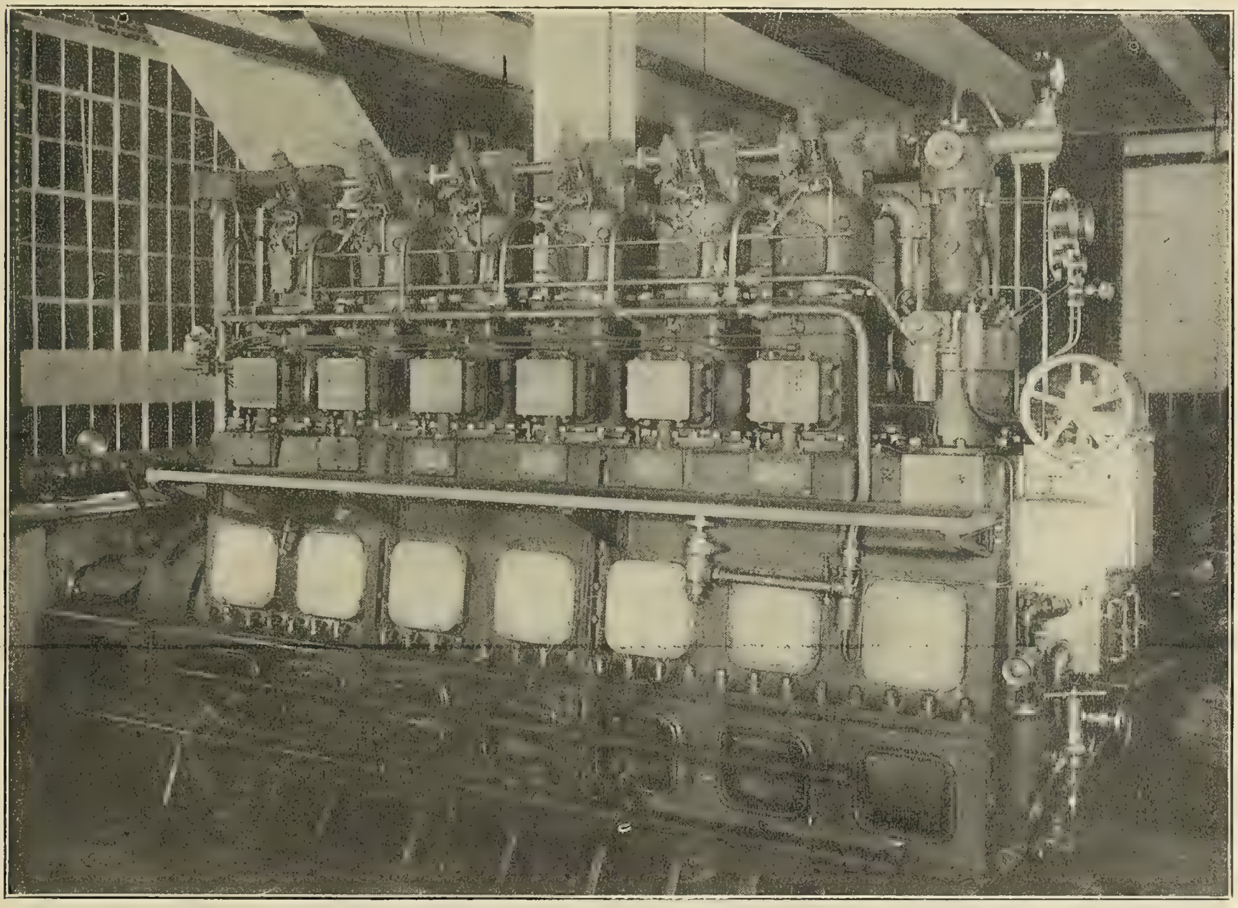
MARCH, 1912

The First American-Built, Diesel-Engined Oil Barge

The Standard Oil Company, New York, is having built a 200-foot steel motor barge of about 1,500 tons deadweight-carrying capacity, in which the propelling machinery consists of a 300-horsepower heavy oil engine, and all the deck and pumping machinery will be operated by oil motors, dispensing entirely with the use of steam in operating the vessel. This is the first American-built vessel to use this type of power, and, in view of the rapid advance which is being made in Europe in the use of this type of propelling machinery, the details of the vessel are of particular interest to American shipbuilders and marine engineers. The hull is being built by the Staten Island Shipbuilding Company, of Port Richmond, New York; the propelling machinery by the New London Ship & Engine Company, Groton, Conn., and the ship will be completed and placed in operation in the spring.

The principal dimensions are: Length between perpendiculars, 200 feet; beam, molded, 35 feet; depth, 15 feet 6 inches. The vessel has a capacity of about 500,000 gallons of oil, or a deadweight-carrying capacity of about 1,500 tons. When fully loaded to a draft of 14 feet, the block coefficient is about .75. The ship was designed to trim 6 inches by the stern when fully loaded.

The design of the vessel follows the usual practice in Standard Oil barges, with the exception of the use of internal combustion engines for supplying power for all purposes on board the ship. The hull is subdivided by nine oil-tight bulkheads into ten compartments. Eight of these compartments are tanks for carrying cargo. The forward compartment contains the cargo pump, chain locker and other equipment. The after compartment contains the propelling machinery, fuel oil tanks and a fresh-water tank. The crew's quarters are contained in a deck house on the main deck above the engine room and around the engine-room hatch, which is 15 feet 9 inches long by 5 feet 2¾ inches wide, covered with a skylight.

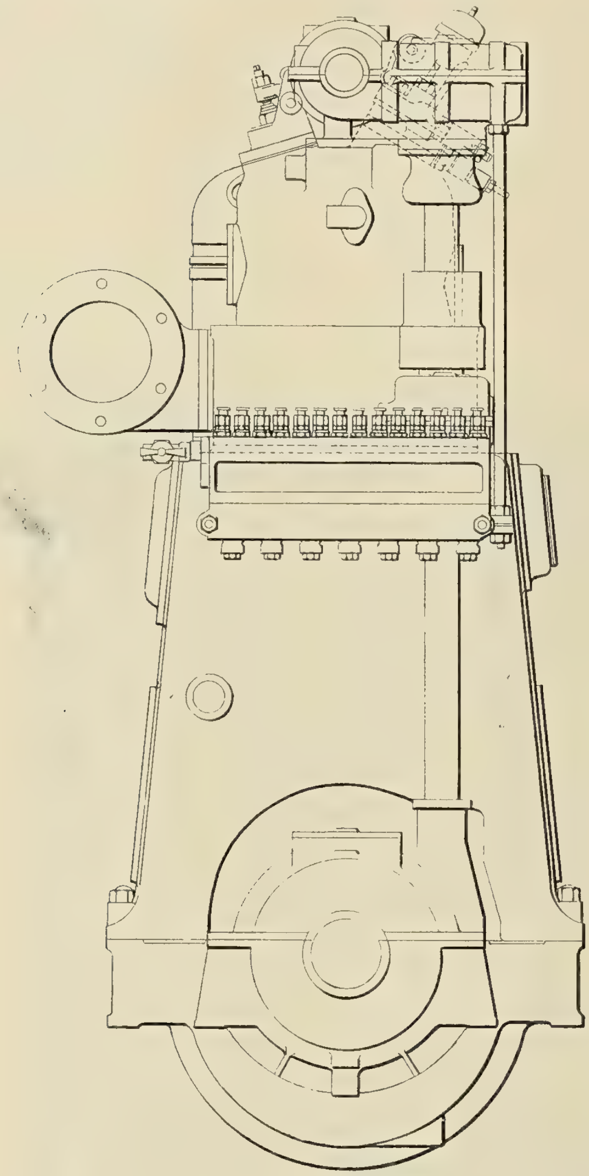


300-HORSEPOWER AMERICAN-NUREMBERG ENGINE FOR THE STANDARD OIL MOTOR BARGE

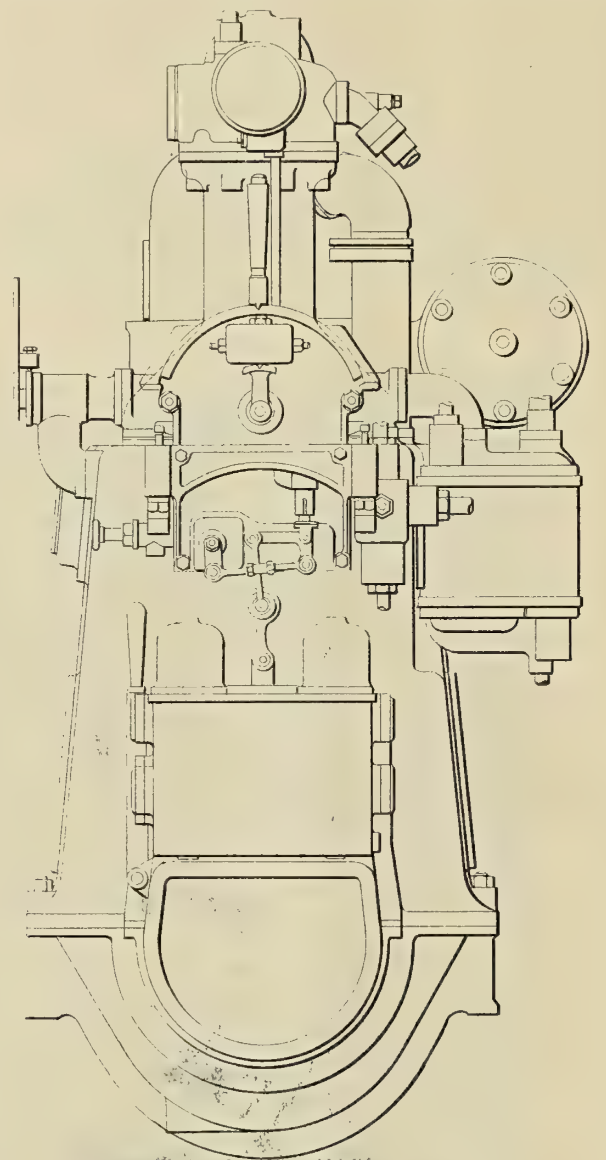
On each side of the engine-room casing is a stateroom containing two berths. Aft of the engine-room casing is the mess room and galley. The forward part of the deck house contains two staterooms, one with two berths and the other with one berth and desk for the captain's use. The pilot house is directly over the forward end of the deck house. In the sleeping quarters is installed a heater with connections on both port and starboard sides for connecting to a tug or dock when in port, and there are also connections to the main engine circulating water.

and stringers are placed, as shown, on the midship section, except that there are extra side stringers in the forward compartment, two on each side, extending from the forward oil bulkhead to the stem. They are made of 6-inch by 3-inch by 8/20-inch bulb angles.

The nine transverse bulkheads are built of 6/20-inch plate with 8/20-inch floors, and are stiffened by vertical angles, 4 inches by 3 inches by 7/20 inch, spaced about 20 inches. Three web stiffeners, 24 inches by 7/20 inch at the bottom, reduced to 15 inches by 7/20 inch at the top, with double 3-inch by 3-inch



AFT END VIEW OF MAIN ENGINE



FORWARD END VIEW OF MAIN ENGINE

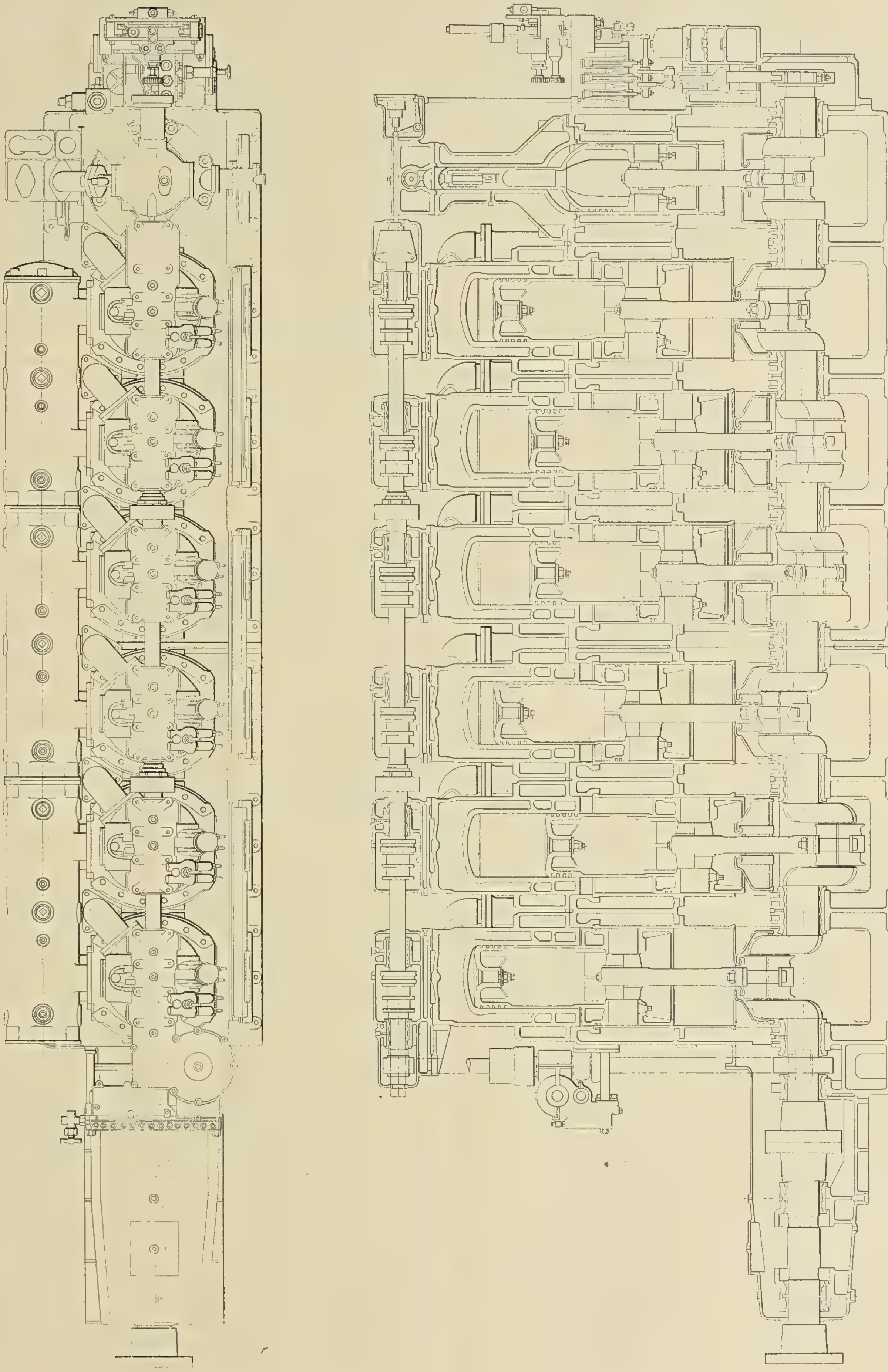
by 6/20-inch angles at the edge, are worked on each bulkhead in the position shown on the general arrangement plans. These web stiffeners are connected to the bulkheads by 3-inch by 3-inch by 7/20-inch angles. One horizontal stiffener of 7/20-inch plate, with 5-inch by 3-inch by 8/20-inch angles on the inner edge, is worked intercostally between the webs and shell. This stiffener is connected to the bulkhead by 3-inch by 3-inch by 7/20-inch angles. The end bulkheads in the oil space have web stiffeners 50 percent deeper than those on other bulkheads.

Hold beams, 6 inches by 3 inches by 8/20 inch bulb angles, are located as shown on the plans at each web frame.

The expansion trunk is 17 feet wide by 27 inches high, as shown on the plans. Swash plates are placed above the deck

Hull Construction

The main scantlings of the hull are shown on the midship section. The stem and stern post are of forged iron, the stem being 7 inches by 2¼ inches and the stern post 7 inches by 3¼ inches. The frames are bulb angles, 6 inches by 3 inches by 8/20 inch, spaced 24 inches except in the forward compartment, where they are spaced 21 inches, 18 inches and 15 inches, as shown on the general plans. Reverse frames, consisting of 3-inch by 3-inch by 6/20-inch angles, are placed on every floor extending across the tops of the floors. One web frame is placed in each cargo compartment, and in the forward compartment there are two web frames. The web frames are built of plate, 18 inches wide by 7/20 inch thick, with 3-inch by 3-inch by 6/20-inch angles on the face. Keelsons



SECTIONAL VIEW OF 300-HORSEPOWER DIESEL ENGINE FOR THE STANDARD OIL MOTOR BARGE

under the expansion trunk on the center line, and ridge bars are located on each side of the trunk. These are all continuous between bulkheads. Cargo hatches 4 feet square are located as shown on the deck plan. There is one 4-inch relief valve and one 10-inch manhole on the expansion trunk for each oil compartment. The cargo main is of 8-inch wrought iron pipe, with one 6-inch, one 4-inch and one 3-inch valve and bell-mouth suction in each compartment. Loading connections are located forward and aft on both sides, and there is also a 6-inch independent loading line in each compartment leading from the top of the expansion tank to the bottom of the barge.

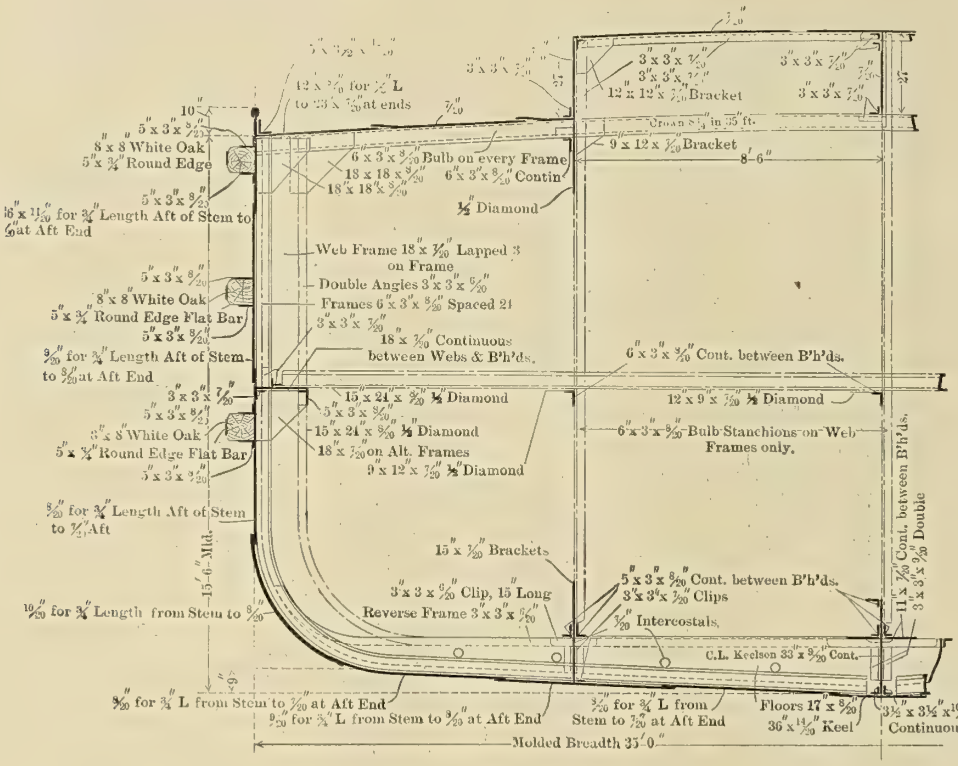
The windlass and the oil pump are driven by a 25-horsepower oil engine, located on the deck forward, and driving a countershaft, which is provided with a clutch and geared to the windlass on the deck and the cargo pump in the forward compartment. Bilge pumps to draw water from the ends of the barge are hand pumps of the Cataract type with 3-inch suctions. The engine room bilge pump is driven off the main propelling engine, as will be explained later.

Propelling Machinery

The main engine is a heavy oil internal-combustion engine of the type manufactured by the Maschinenfabrik Augsburg-Nürnberg Company, of Nuremberg, Germany, of which the New London Ship & Engine Company, Groton, Conn., is the American licensee. It is a two-cycle Diesel engine, with six working cylinders and a two-stage air compressor on the bedplate. As is common with large Diesel engines, starting and reversing is accomplished by compressed air, and the fuel oil is sprayed into the cylinders by compressed air and ignited by the heat of the fresh charge of air compressed in the working cylinder during the up-stroke. Each working cylinder is supplied with an independent scavenging pump to clear the cylinder of the burnt gases.

The working cylinders are 9 1/16 inches diameter, 15¾ inches stroke. The engine is designed to operate at 300 revolutions per minute, developing 300 horsepower. On a 200-hour trial of this engine the brake-horsepower actually developed was 374 at 300 revolutions per minute, the fuel consumption being about ½ pound per horsepower-hour.

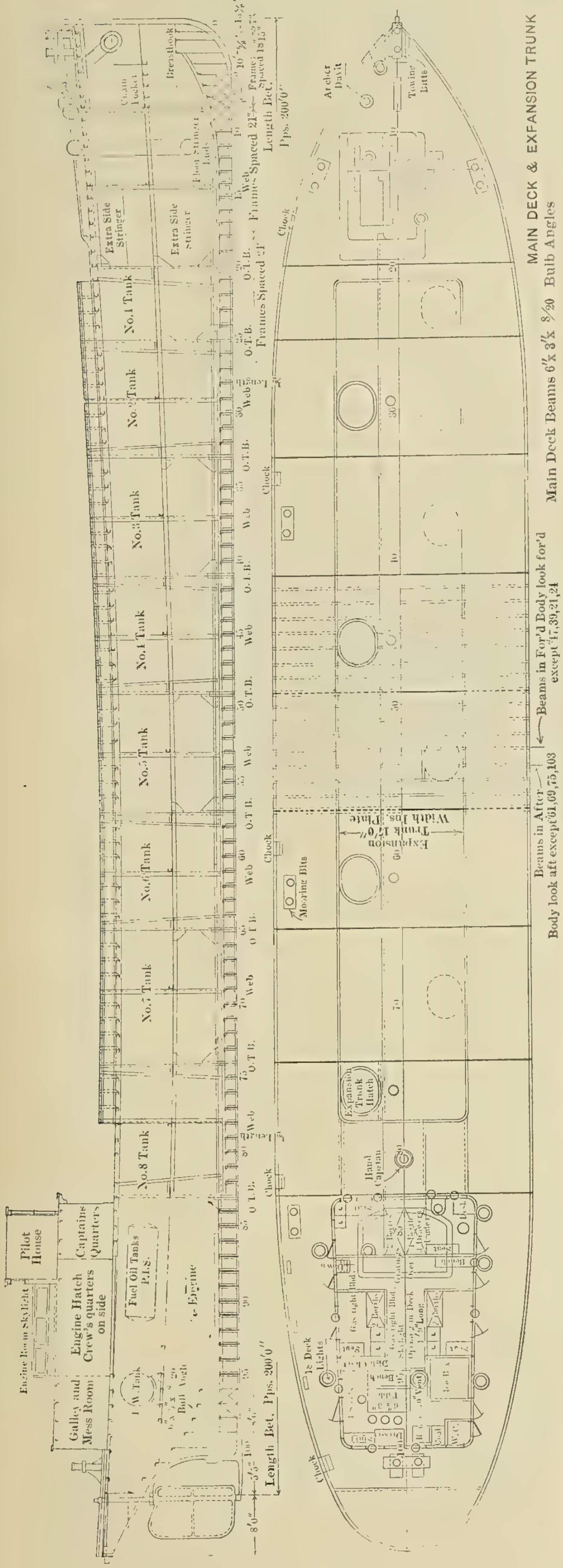
As will be seen from the drawings of the main engine, step pistons of the trunk type are used; that is, the working piston is prolonged and enlarged to serve as the piston for the scavenging pump. This arrangement takes care of the thrust from the connecting rod and guides the piston. Such a design, of course, increases the height of the engine, but it decreases the length and also the cost and weight of the engine by combining the working pistons and scavenging pump pistons. Each working cylinder, therefore, has its own scavenging pump, which supplies air at a pressure of about 7 pounds per square inch into a reservoir in the upper part of the crank case for clearing out the working cylinders on each stroke. As shown in the drawing the working piston and scavenging pump piston are a solid casting, but in the latest design of this engine we understand that the working piston and pump piston are cast separately and joined by bolts to permit dismantling the engine more readily.



MIDSHIP SECTION

Forced lubrication is used, the pumping arrangement being located on the after part of the engine, the oil being led through the hollow crankshaft and up the connecting rods to the gudgeon pins, where the oil is carried through tubes to the heads of the working pistons, and circulates through spaces in heads of the pistons for cooling purposes. The oil flows by gravity to the crank-pit, and after it is cooled and filtered it is again circulated through the lubricating system. Shields are fitted for the crank webs to prevent an excess amount of oil reaching the scavenging pumps.

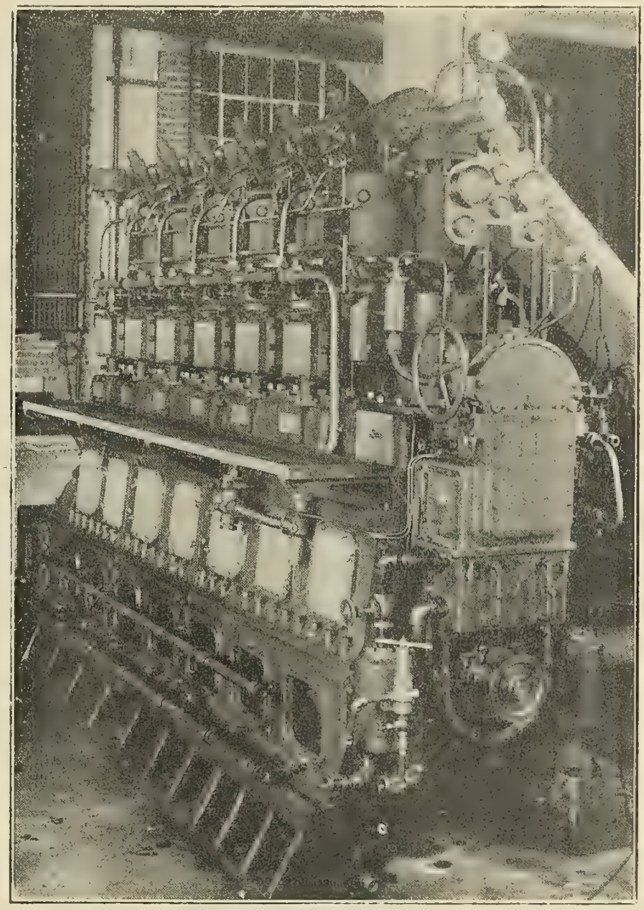
Each working cylinder has three valves in the head of the cylinder, one being for the admission of fuel, one for scavenging air, and one for admitting compressed air. The latter is controlled by two plungers, one for starting the engine ahead and the other for starting astern. All the valves are cased in, and a single cam-shaft runs along the tops of the



INBOARD PROFILE AND DECK PLAN

cylinders, carrying a separate cam for each valve. The cam-shaft is driven by a vertical shaft at the after end of the engine, which is operated by helical gears from the crankshaft. The vertical shaft is not solid its entire length, but has a dog clutch coupling which has a play of 30 degrees between the driving and the driven face, so that when the engine is changed from going ahead to going astern the motion if the cam-shaft relative to the crankshaft is changed corresponding to the play in the vertical shaft, causing the valves to operate with the desired lead in connection with the stroke of the piston.

Fuel is supplied to the cylinders from a group of pumps which are located at the forward end of the engine. There is one fuel pump for each cylinder, but the whole are grouped together, as shown on the drawing, the pumps being driven



VIEW OF MAIN ENGINE, SHOWING CONTROL APPARATUS

from an eccentric on the main crankshaft. These pumps can be adjusted to deliver a determined quantity of fuel to each cylinder corresponding to the speed desired. The speed for this type of engine can be varied to about 30 percent of the maximum. The time of opening and the duration of opening the fuel valves in each cylinder are controlled by a single cam for both the forward and reverse movement of the engine. The necessary lead in each case is obtained from the play in the vertical driving shaft. The same is true of the scavenging valves.

With the compressed air valve for admitting air compressed to about 800 pounds per square inch for starting the engine when going either ahead or in the astern direction, separate control plungers are provided, each operated by its own cam, the air being admitted to either control plunger desired by the main control lever of the engine. The proper cam for the required direction is brought into action by the interposition of a small disk between the cam and plunger.

This movement of the engagement of the disk is performed by the movement of the single control lever.

The control lever which is shown on the drawing in the mid position can be moved in two ways, one which starts the engine ahead and the other astern. Moving the lever through an angle of about 45 degrees admits compressed air to the air-starting valve control plungers, and the engine operates on the compressed air. As the lever is moved beyond this intermediate point the fuel oil is automatically admitted and the compressed air shut off, so that combustion begins to take place in the working cylinders before the operation on compressed air has entirely ceased. This method of control by the movement of a single lever makes the action of the engine positive, and does not give the engineer an opportunity to make any mistakes. He simply has to pull the lever from one side to the other according to orders, and the various operations are automatically carried out by the compressed air control on the valves until the engine takes up the work, the compressed air for starting being cut off and the supply of fuel gradually increased.

The air compressor, as shown in the drawing, is a two-stage compressor in a single cylinder, which delivers air at about 800 pounds per square inch into an air reservoir alongside the engine. Surplus air is led from this reservoir to other tanks, which are kept in order to furnish a sufficient supply for maneuvering.

The engine is supplied with a roller-thrust bearing and a jaw clutch for connection to the propeller shaft, so that the engine can be disconnected and run independently of the propeller when desired. The engine room bilge pump is driven direct from the crankshaft, and part of the circulating water is to be used for heating the sleeping quarters.

This engine has been completed and given a thorough testing in the builders' shops. After a 200-hour test, when the engine operated very satisfactorily, it was dismantled, and all the moving parts were found in splendid condition.

The weight of the engine complete is 28,000 pounds. The fuel oil is carried in two tanks, one on the starboard and one on the port side of the engine room, each having a capacity of 1,100 gallons. There is also a 750-gallon fresh water tank in the engine room and a 250-gallon lubricating oil tank.

The performance of this ship will be awaited with exceptional interest, because the engine is of a type which has already been built in Germany in units up to 12,000 horsepower and bids fair to give unusual results in the matter of economy.

Rapid Work on the U. S. Collier Orion

A good example of rapid ship construction is evident from the photograph shown herewith, which was taken two months after the keel of the vessel was laid. The vessel was the collier *Orion*, which the Maryland Steel Company, Sparrows Point, Md., is building for the United States government on the Isherwood system. The contract for this collier was awarded on Aug. 22, 1911; the first material was received at the builders' yard on Sept. 22, and the keel laid on Oct. 6. At the date the photograph was taken over 2,500 tons of material had been assembled and riveted, the cargo holds being entirely completed and the ship in frame from stem to stern post. The plating had proceeded through the cargo holds, and the top side tanks in way of the cargo holds. The builders are well justified in claiming this a record in building for a vessel of this size.

COLLIER ORION TWO MONTHS AFTER LAYING THE KEEL

The general dimensions of the ship are as follows:

Length over all....................	536 feet.
Length between perpendiculars.....	514 feet.
Beam, molded......................	65 feet.
Depth, molded to upper deck.......	39 feet 6 inches.

Among engineers and commercial authorities there is a conviction that the coming sessions of the Twelfth International Congress of Navigation, to begin in Philadelphia on May 23, will have a deep influence upon waterway projects of national importance that are now in contemplation. This view of the significance of the coming deliberations of world-famous engineers is borne out by a statement made by A. Dufourny, one of the two presidents of the Congress, who is also Inspector-General of the Belgium Corps of Engineers. In touching upon the influence which the Congress has had in the past upon waterways development, Mr. Dufourny makes the statement that the transformation of the Erie Canal for 2,000-ton boats was inspired by ideas developed at the Congress of Vienna. The Congresses of Navigation bring together the engineers and specialists who in all parts of the world have to carry out the works required to adapt canals, ports and rivers to the needs of the public. Each is at these sessions benefited by the knowledge, the studies and the experience which his colleagues have acquired. The questions are treated from broad, general and universal points of view. The union of efforts has brought about in a few years great and rapid advances in the vast domain of hydraulic works.

A Retrospect of Fifteen Years of Ship Design and Construction

BY PROF. C. H. PEABODY

The contest for maritime supremacy on the North Atlantic during the last fifteen years has excited a keen general interest, even a sporting interest, as each new competitor snatched the record only to yield it to a larger and swifter ship. The race is no new thing, but the zest has been the greater because there has been a general as well as a professional appreciation that we have been approaching the grand culmination of the strife. A sober review of the situation will the better enable us to grasp the meaning of the contest and the magnitude of the success.

Twenty years ago there were two classes of steamers—passenger steamers and freighters. All steamers carried freight as an important if not the principal business, but passenger steamers sought a regularity and a speed that would attract passengers. The *Servia*, which was a good ship in her day, may serve as an advanced type of the passenger ship. She was 517 feet long, had over 9,000 horsepower, and could do better than 16 knots at sea; a good, reputable speed even to-day on any other course than the North Atlantic. Such a ship could go anywhere, without paying much attention to wind or weather, and carry her passengers with safety and comfort. It is true that a prudent master would respect winter gales, but he knew it meant only a day or two extra on the passage. It is fair to say that the shipbuilder had conquered the ocean and that the navigator feared nothing but the land.

But the transatlantic lines had a clear grasp of the idea that the record for the fastest ship was worth money, and that people were ready to pay roundly for the éclat of traveling by the ship that held the record and for the privilege of enjoying a day less on the passage. So there was built up the great fleet of express steamers, the pioneers of progress in shipbuilding, that developed and paid for the advantages that now are to be had by all travelers by sea.

Express Steamers

As a full-developed type of express steamer let us choose the *Campania*, which was completed in 1893, and therefore antedates our fifteen years by four years, but which held the record well into our period. She was 600 feet long, had 31,000 horsepower and made 23 knots. In displacement she was nearly twice as large as the *Servia*, and she had more than three times as much power, and (roughly) went half again as fast. It is clear that in order that the owners could recoup their expenses the passengers must pay roundly for a relatively small advantage. At first blush it would not appear that the record-breaker was so very much of a credit to the builders after all. In order to understand what had been accomplished and how great a triumph of engineering skill the *Campania* really was, we must look a little into the elementary theory of the effect of size on speed.

Now, the controlling element for speed of well-formed ships is length, and it is only when an intelligent understanding of this relation is kept in mind that we can judge of the success of any new record-breaker. William Froude long ago laid down the law that the relative speeds of ships were proportional to the square roots of their lengths. If then the *Campania* were simply a longer *Servia* her speed should be $\frac{\sqrt{600}}{\sqrt{517}} = 1.08$ as great; that is, there would be a gain of about 8 percent. If the *Servia* could be credited with a trial speed of 16.7 knots the greater *Servia* would have 18 knots, whereas the *Campania* made 23 knots. Now we begin to see why she had to pay the price for holding the record for a few seasons.

In 1900 the record passed to the German lines, a matter to be well considered, for the Germans are a comparatively new people in the competition. The *Deutschland* raised the speed to 23.5 knots by increasing the length to 663 feet and the power to 36,000. The newer German ships were larger but not faster, and so the matter rested till new elements entered the competition.

For reasons of State the British Admiralty concluded that it was not well to have any steamers afloat that they could not catch, and so arranged a special subvention for the building of the *Lusitania* and the *Mauretania*, which would appear as auxiliary cruisers should there be danger that peace would be broken. Both peace maneuvers and war experience have shown that the express steamer is hard to drive away. True, she does not await the coming of a cruiser, but when the cruiser turns back to regain touch with the fleet so also does she, and remains just beyond range. The British Admiralty having now a number of battle cruisers that do 25 knots or better, the subvention of express auxiliary cruisers cannot be looked for as a stimulus to a renewal of the race for the Atlantic record.

The most striking feature of these express steamers is, after all, not their great size nor their exceptional speed, but the application of turbines to propulsion on so large a scale and so soon after the development of the marine steam turbine. But this story, which would be extravagant if it were not true, is given by another writer in this number of International Marine Engineering. To that writer may be left the question whether the enormous 70,000 horsepower of these ships would be possible with reciprocating engines.

Speed-Length Ratio

A most useful method of comparison of speeds of ships is the speed-length ratio; that is to say, the ratio of the speed of the ship in knots to the square root of the length of the ship in feet. Algebraically, this is represented by the expression $\frac{V}{\sqrt{L}}$, where V is the speed in knots and L is the length in feet. Applied to the *Campania* this gives $\frac{23}{\sqrt{600}} = 0.9$, and all the successive record breakers up to the *Lusitania* have the same value for the speed-length ratio, so that they were straight examples of out-building. With some reservation it may be said that the record may always be won by the expedient of building a larger and more powerful ship if the shipbuilder is given a free hand.

Now the *Mauretania* attained a speed of 26 knots on trial, with a length of 760 feet. Applying the test just stated, it is clear that she is more than a larger *Campania*, for her speed-length ratio is $\frac{26}{\sqrt{760}} = 0.94$, which shows that in a certain sense she is a better ship as well as larger.

Have we then arrived at a finality? In a recent paper before the Society of Naval Architects and Marine Engineers, the distinguished naval architect, Sir William Henry White, indicated clearly that he thinks we have come very near to that

condition. None knows better than he that a new ship might get the record by a narrow margin, following the well-known expedient of out-building, and few know so well the cost of winning in that line. We may easily agree with him that these magnificent steamers fill all reasonable demands for speed and regularity of passage. For example, the *Mauretania* made fifteen round trips in a year, and varied in speed only from 25 knots to 26 knots, meeting in the year all kinds of weather.

In the latest competition for favor on the Atlantic route the *Olympic* and *Titanic* have definitely declined the race for speed, preferring to give their vast size and bulk to convenience and luxury of passenger accommodation and to cargo capacity. Their speed of 21½ knots on trial is, after all, a high speed and obtained with a relatively moderate power. With a length of 850 feet this gives a speed-length ratio of $\frac{21.5}{\sqrt{850}} =$ 0.75, which is a trifle more than that of our old friend the *Servia*. There seems then to be a return to the conservative type of the freight and passenger ship which has found favor on all routes except the North Atlantic. The size of these ships is partially limited by the draft of harbor channels and by the demands of transportation. The great and increasing cost of deepening channels will delay further improvement in that line till the demands of commerce are urgent, and so it may be expected that the immediate future will see a larger increase of numbers of such steamers before much increase in size.

Early Pacific Steamers

At the beginning of our fifteen years of retrospect the voyage to Japan and China was made in a leisurely way by the steamers of the Pacific Mail and the Occidental and Oriental lines, operating conjointly. The former still headed her list of ships by the *Pekin*, built about 1877, and the latter had in service out-classed Atlantic liners like the *Coptic*. The *Pekin* was heavily sparred and depended largely on her sails. On this lonely stretch of water the wail of the Chinese sailors shifting sail in the night was not an unwelcome sound to the passenger, as the writer well remembers. In 1891 the Canadian Pacific Railroad put on the *Empress of India* and two sister ships, credited with a speed of 18 knots on a length of 458 feet; the speed-length ratio was, therefore, about 0.84, which would almost entitle them to rank with express steamers.

But the most pretentious change on the Pacific was the advent of the two Japanese steamship companies—the Toyo Kisen Kaisha and the Nippon Yusen Kaisha, one operating a line to San Francisco and the other to Seattle. These ships, of about 450 feet length and 6,000 tons displacement, have been mostly built in England, but the *Hitachi Maru* was built at Nagasaki for the latter company in 1898. The competition of this race of hardy seamen accustomed to the Oriental scale of wages is likely to be keen and persistent.

Intermediate Ships

Together with the demand for regular and fast passenger steamers, the Atlantic trade has demanded large and fast freighters which have been able to offer superior passenger accommodation with passages of not undue length. These have been called intermediate ships which may be characterized by a speed-length ratio of 0.6 to 0.7. The first issue of INTERNATIONAL MARINE ENGINEERING gives a good example of this type in the *Pennsylvania* with a speed of 14.5 knots on a length of 560 feet; the speed-length ratio is 0.61. To get the passenger accommodation where it would not interfere with the loading and unloading of cargo it was placed well above the water amidships. Passengers who cared little for record breaking, and did not fear a few more days at sea, were quick to learn that these ships were more comfortable than the crowded express steamers. Such a ship as the *Saxonia*, with a speed of 16 knots, could make the Atlantic voyage in eight days and afford every comfort and luxury. Of this class were the *Dakota* and *Minnesota*, built in 1903 by the Great Northern Railroad for the Pacific trade. The loss of the *Dakota* is greatly to be regretted, and still more the conditions which have determined that she will not be replaced. With a sea speed of 14.5 knots on a length of 630 feet the speed-length ratio is 0.58. There is an occasional tendency to class the *Olympic* with these intermediate steamers, but in my opinion such classification is misleading, for though she has an enormous freight capacity she is clearly a passenger steamer, though not of the type of express steamer.

A typical American ship is represented by the coastwise steamer *Madison* of the Old Dominion Line, which differs from the Atlantic liner mainly in size, for a speed of 15¾ knots on a length of 374 feet calls for a speed-length ratio of 0.81, which should qualify for any class except that of express steamer. Having all passenger accommodation on the upper deck these steamers offer quite as much comfort as the Atlantic liners, though there is less ostentation. This type was so well and so early developed that there is to record only a normal growth in size and speed. The business of these steamers is largely carrying freight, which is commonly handled by man-power and is very expensive, the loading and unloading costing as much as the transportation of a thousand miles or more This will be contrasted later with the handling of bulk freight on Lake steamers.

Ocean-Going Cargo Steamers

Our attention has been given thus far to ships that carry passengers and which make some pretense to speed, but the great bulk of the business of transportation is by the freighter of moderate draft and displacement which can make long voyages at slow speed and enter all harbors. The "tramp" has acquired its characteristics since the United States has been practically out of the foreign freight business, it being a matter of note that a few freighters have been so far rebuilt in our country as to acquire register. These characteristics have largely been controlled by shipping laws and insurance regulations which have not always worked wisely, as, for example, in the *well-decked* steamer, which has a great *well* forward and a discontinuous deck. There has, however, been a marked improvement in recent steamers of larger capacity, especially in connection with more logical deep-frame construction, which gives at once greater strength and freer holds.

We are accustomed to think of the ship as consisting of a frame for strength and a skin to exclude the water; really the shell is the ship and the framing is to hold the shell up to its work. This framing must have longitudinal and transverse members; the latter are given unwonted proportions in the bottom so that the ship may be safely launched and docked. Until recently the skin was held in place mainly by the transverse members, which were closely spaced for that purpose. The longitudinal support for the skin by the Isherwood system allows a wider spacing of frames and a radical reduction in weight of hull. So brief a statement as this must be is necessarily inadequate and faulty, but at least emphasizes the ideas of the inventor.

Great Lakes Bulk Freighters

But if we have not entered into the freight carrying of the world we have developed a line of our own on the Great Lakes which has shown a more rapid advance and greater originality than any other development of shipbuilding. The conditions and restrictions called for a special type of ship, and having once broken away from tradition the builders have followed radical and logical lines. An enormous mass of bulk freight is handled on a draft of about 20 feet on inland waters,

mainly in the summer months. Though the voyage is about a thousand miles from Duluth to Buffalo a moderate speed of 11 or 12 statute miles per hour is chosen; if the steamer has a barge consort the speed is less. In 1897 steamers 400 feet long and carrying 4,500 tons were in service; by the end of the century the length had increased to 500 feet, and a steamer and consort could move 20,000 tons.

Built to carry a large dead load on a moderate length and small draft, with a moderate speed, the hull could have a long uniform 'midship section, though well shaped at the ends. The engines are stowed right aft; watertube boilers with a high steam pressure are used which facilitates the reduction of size and weights of the engines. To provide for rapid loading and unloading the hold is given an unbroken sweep right forward and practically the whole deck is made up of hatches. The first steamer designed for unloading directly by the grab-bucket without hand labor was the *Wolvin*. The sides of the hold in this case slope inward to trim the cargo of ore inward where the grab-bucket can reach it; massive arches span the hold. Later ships had sloping sides for somewhat more than half the depth of the hold and vertical sides, because it was found that the buckets could work into the corners conveniently. These buckets first scrape up the ore, then close on it, hoist it and transfer it to the ore pile alongside, each bucket having a capacity of 5 tons. The ship in this system becomes only a link in the chain of transportation which carries the ore from the mines in upper Michigan to the furnaces in Pennsylvania more cheaply than elsewhere in the world.

SHALLOW DRAFT PADDLE-WHEEL STEAMERS

The paddle-wheel steamer, beginning with Fulton's *Clermont,* soon developed into a characteristic type fitted for the navigation of our inland waters. The type may be considered to have come to maturity in the *Mary Powell,* which, with a speed of 17.2 knots on a length of 286 feet, was for a long time the fastest vessel. The hull, first of wood and later of steel, long and fine, was suited for speed in shallow water. The paddle guards are carried right forward and aft and faired into the sheer line of the hull. On this broad platform is built up an enormous and luxurious passenger accommodation, so that the great floating hotels, *Priscilla* and *Commonwealth,* of the Fall River Line, are licensed to carry 1,500 passengers. These magnificent steamers, which were built, one near the beginning and the other near the end of our fifteen-year period, on a length of 440 feet, can make 21 knots, so that their speed-length ratio is 1.00.

The great height of superstructure, and the fact that such steamboats navigate protected waters, allow the use of large paddle-wheels, which could properly have radial floats. Since trips were short and fuel economy of secondary importance, the simple beam engine held its own for a long time, being favored by simplicity of construction and ease of maintenance and repair. The Fall River steamers with 10,000 horsepower were given inclined engines and feathering paddles. With these improvements the steamboat is likely to remain in favor in its native country.

It is quite otherwise in the stormy channels about Great Britain, which are navigated by small high-powered steamships. In 1897 the old paddle type represented by the *Ireland* was superseded by the twin-screw steamer, like the *Ulster.* Now the service is performed mainly by turbine steamers, which do not differ in appearance from the *Ulster.*

Returning to our subject of steamboats, we find that the most recent river boats, like the *Quincy,* differ in no way from the flush times, "before the war," when Mark Twain was pilot. The paddle-wheels, located well aft, are driven by independent horizontal engines. The great headroom under the cabin deck is to receive the cargo, and a gang plank at the bow facilitates landing along the river bank.

MOTOR BOATS

The most sensational feature of the last fifteen years is the development of extravagant speeds with small craft. At the beginning of this period steam was the propelling agent, and with it the *Turbinia,* furnished with Parsons turbines, made 32.75 knots on 100 feet, so that she had a speed-length ratio of 3.275.

After the gasoline (petrol) engine had been perfected for motor cars its application to high-speed boats was at once evident, and led to the use of the convenient, though somewhat incongruous, term "motor boat," since all boats propelled otherwise than by oars or sails may claim the name. This type of craft is well illustrated by the *Veritas,* which made a speed of 29.2 miles on a length of 54.3 feet, the equivalent speed of 25.4 knots, giving a speed-length ratio of 3.4. They are, of course, smooth-water craft, and are essentially toys, but are most interesting as showing the conditions required for extreme speed. An extreme development of this toy is the hydroplane, which skims along the surface of the water and has no proper waterline length, and consequently cannot be said to have a speed-length ratio.

SAILING SHIPS

It is with a certain feeling of regret that we consider the beautiful ship *Dirigo,* built of steel at Bath, the old home of the American wooden clipper ship, because it seems to close a long chapter of the history of shipbuilding. Even the wooden schooner, with its multiple number of masts, its power-hoisting gear and its pitiful tale of men, two for each mast, and two more, including captain and cook, will soon be a thing of the past. Even the phlegmatic Dutch have turned from the picturesque to the practical and are building steel barges and lee-board luggers. The six-masted schooner *George W. Wells,* carrying 5,500 tons burden, has a crew of fourteen and a 30-horsepower boiler; all hoisting and hauling is done by steam, and there is a steam steering engine, a most efficient and business-like combination. It is regrettable that such fore-and-afters are not suitable for ocean navigation, because the application of power to square riggers is not so practical, and so their day will the sooner be over.

NAVAL VESSELS

If the last fifteen years has shown a culmination of the competition for size and speed of merchantmen, we realize that we are now in the midst of a mad race for supremacy in naval material. In that time the United States has advanced from a position of inferiority to that of one of the trio of great naval powers. At the beginning of this period the naval world had developed a definite type of warship, which indeed showed variations but not what the naturalist would call specific differences. This type reflected the condition of naval gunnery then existing, a condition shown by the battle of Santiago, in which there was 3 percent of hits, though it must be admitted that this, like the rest of the action, was a caricature of a naval action. The type can be represented by the British battleship *Majestic,* which on a displacement of 14,900 tons made 17.9 knots on trial. The length was 390 feet and the speed-length ratio 0.9, like that of an express steamer. The battery consisted of four 12-inch guns and twelve 6-inch guns. It was expected that actions might be fought at 3,000 yards, at which the 6-inch guns could destroy all but the heavy waterline belt and the big gun positions; the 12-inch guns, which were slow in fire and uncertain in hitting, were carried to give the *coup de grace.* Such an authority as Captain Mahan considered the 6-inch guns as the main battery.

The year 1897 saw the completion of our first modern seagoing battleship, the *Iowa,* which on a displacement of 11,000 tons made a trial speed of 17.1 knots, but as her length was only 360 her speed-length ratio was 0.9, which is nearly a

maximum for heavy ships. She exhibited the American abiding belief in big guns and plenty of them, for she carried four 12-inch guns and eight 8-inch guns; she carried also ten 4-inch guns on the broadside. Now the 8-inch gun is about two and one-third times as big as a 6-inch gun, and therefore, in a sense, the battery carried by the *Iowa* was equivalent to eighteen sixes. The 8-inch gun, which is after all a big gun, has been carried in the secondary battery of all our ships from that time on, except some half dozen which conformed to the British type. In these days of big guns and long range it is fortunate that our ships carry so many of them.

In 1904 Italy began mounting 8-inch guns on battleships, and in 1905 Great Britain mounted 9.2-inch guns, which though more powerful are in the same class, thus following our lead. There is good ground for difference of opinion concerning the relative advantages of big-little guns like sixes, and little-big guns like eights and nines, and the use of the latter may indicate only a desire to give an appropriate battery to ships that were continually growing in size; thus the *King Edward* has a displacement of 16,350 tons, against the 14,900 of the *Majestic,* and carries four 12-inch guns, four 9.2-inch guns and ten sixes instead of four 12-inch guns and twelve sixes.

Meanwhile two influences had been acting to bring about a radical change in battleship armaments and a great increase in size. One influence, but probably not the predominant one, was the increase of the range of the automobile torpedo to 3,000 yards, and the other, which alone would have sufficed, namely, the construction of efficient range finders. Naval artillerists of all nations were alive to the fact that the most destructive fire against ships was with heavy shells—provided they hit. Then began the marvelous development of naval marksmanship with heavy guns together with an increase in the rate of fire. In consequence the battle range has been increased to 6,000 yards or more, so that the 6-inch gun becomes quite ineffective. The effect of this change is to insure the predominance of the big gun, and nothing must be allowed to interfere with its effectiveness. This rules out even the secondary big gun like the 9.2-inch or the 10-inch guns.

In 1906 Great Britain launched and completed the *Dreadnought,* which carried ten 12-inch guns on a displacement of 17,900 tons at a speed of 21.8 knots. The length is 490 feet, so that the speed-length ratio is only 0.88. The United States, having independently studied the same question, followed with the *Michigan* and *South Carolina,* which carried eight 12-inch guns on the centerline, on 16,000 tons displacement, with a trial speed of 18.8 knots. These ships were launched in 1907 and completed in 1908. They were to some extent controlled by the habit of Congress of including both cost and size in bills authorizing construction of ships, and the true American big-gun ship is represented by the *Delaware,* completed in 1910, which carries twelve 12-inch guns on 20,000 tons displacement at 21.5 knots. The peculiar feature of these ships, which carry all guns on the middle line, so that they are equally effective on both sides, has finally been adopted by all nations for their first-class ships.

Armament of Warships

The big gun idea is not new, for the tendency of building the largest practicable gun and mounting it on all ships was clearly marked in our navy before the Civil War; that gun was the eleven-inch cast iron smooth-bore, the best naval gun then afloat, and it was chosen because it had the advantage of range and destructiveness. During the war the fifteen-inch gun was developed for the monitors to give power, much as now the desire to increase power leads artillerists to turn to fourteen-inch guns. With this history in mind the writer as early as 1902 asked a well-known naval designer, "Why not mount twelve-inch guns only?" and the answer was that the step was too great to be taken at once.

Should it once be settled what type of big gun is most effective, then the corresponding type of battleship could be worked out on the basis of the number of guns that could be worked effectively. Now the size of the gun, in the end, depends on such metallurgical operations as forging and tempering the great tubes of which such guns are built up, and of these, one at least—namely, the tempering—is a surface operation which probably has been brought to the highest efficiency. As early as the beginning of our fifteen-year period a leading steel maker told the writer that the thickness of such tubes was limited to about seven inches by such considerations, which would account for the failure of early guns of mammoth size. It is hardly wise to set a limit, for limits have a habit of moving upward and onward, but anyone can note that the fourteen-inch gun is given a less muzzle velocity than the twelve-inch gun, which means a less powder pressure. In fact, the coast-artillery, fourteen-inch gun was avowedly designed for a less pressure in order to secure longer life for the gun. But the land gun is set in azimuth and altitude like an astronomical instrument and places its shot with precision, so that flatness of trajectory has not the importance that has always been found at sea, where ranges are uncertain. Perhaps the naval artillerist begins to feel the same confidence in his range-finding, and is ready to seek for longer life of the gun and heavier bursting charges in shells. But whether the gun shall have twelve inches or fourteen inches caliber, it looks as though the question of gun and ship might be soluble if other elements are not injected.

We are sometimes inclined to think that the radical and rapid changes which characterize our times are found only in our times, and that our forefathers were slow, if not inert, not realizing that a rapid change requires two elements—first, the clear grasping of an idea, and, secondly, the ability to carry it out; it is in the latter that we have the advantage preeminently.

Naval Warfare

Such a change took place about the year 1665 in the wars between the English and Dutch in consequence of the formation of the close-hauled line-of-battle. Before this time warships of all sizes were built and all were drawn into the confused battles in which nations strove for mastery at sea. In the war that then broke out between these two nations of seasoned seamen both knew the advantage of the line-of-battle formation and used it so far as possible. In the Four Days' Battle, of June, 1665, the English had 80 ships and the Dutch, 100; there appears to have been much diversity of size and power of ships in both fleets, the Dutch having little advantage from numbers because in general their ships were of less size. Our interest is now not who won, nor how stubborn and bloody was the fight, but that from this war emerged the line-of-battle ship.

The type of ship was already in existence in both fleets and thereafter none but that type was built for the capital fleet. It may be characterized by the two-decker, seventy-four-gun ship, and the three-decker, hundred-gun ship, the tendency on the whole being toward the heavier ship, though it was a poorer sailer and less seaworthy. The size of the gun was limited because it must be man-handled and the ship because built of wood. So well settled was the type that Nelson's *Victory* at Trafalgar in 1805 was eighty years old.

The other type of wooden man-of-war was the single-decked frigate, which accompanied fleets and acted individually but was not placed in the line. The type was thoroughly seaworthy, and so much better a sailer than the line-of-battle ship that it could be brought to action only by ships of the same type. Of this type was the *Constitution,* a little larger, a little more heavily armed, and a little better ship

than frigates of other nations. Great Britain cut down two-deckers into frigates to meet her class.

THE TENDENCY IN WARSHIP DESIGN

This digression is in hopes of finding order in the present situation. In the first place nothing can be allowed to interfere with the true line-of-battle ship; its type may not yet be determined, but when the gun and speed have been settled there is likely to be permanence. Our older and slower ships will, of course, be replaced, but all armored ships carrying twelve-inch guns will surely lie in the line if occasion arises. Not so our armored cruisers like the *Maryland*, magnificent ships which might well lie in the line in her day when the six-inch gun might have decided the day; even the later cruisers with ten-inch guns are outclassed.

At the same time that Great Britain produced the *Dreadnought*, she surprised the world with an entirely new class, the battle cruiser represented by the *Indomitable;* she carries eight twelve-inch guns on 17,250 tons, and has a speed of more than 25 knots on trial; her length being 530 feet, the speed-length ratio is more than unity. The later ships of this type are to be 660 feet long, to make 28 knots, and to carry eight 13.5-inch guns. Germany only has followed in constructing ships of this class. It appears that the battleship and the battle cruiser are in fact two types of line-of-battle ships which are likely to approach as the displacement increases, and that in the end we shall have a well-defined class of large, heavily-armed, fast ships, which type may become permanent unless displaced by an entirely different type of fighting.

The question remains, what type of ship shall take the place of the frigate, the eyes of the fleet which is not expected to lie in the line? The various types of protected and armored cruisers were developed for this purpose, but have all been outclassed by the battle cruiser, as has also the scout cruiser. There is reason to think that the important duty of scouting and of protecting the battle fleet from the enemies' scouts will be performed by vessels of the type of the torpedo-boat destroyer, now really a powerful ship, which deserves a better cognomen. At the beginning of our fifteen-year period this type was well advanced, being represented by the British *Fame,* which, with a displacement of 272 tons, made 30 knots on a length of 210 feet. Our later type is represented by the *Flusser,* which has a displacement of 700 tons, and can make 33.7 knots on a length of 289 feet. The *Flusser* has steam turbines, which developed nearly 12,000 horsepower; this may be contrasted with the 5,800 horsepower of the reciprocating engines of the *Fame,* and so we may estimate the cost of the relatively small increase in speed. On the other hand, the *Fame* carries one 12-pounder and five 6-pounders, while the *Flusser* has five 13-pounders. The increase in tonnage from 272 to 700 very much increases the weatherly qualities of the vessel. It is likely that the displacement may reach 1,000 tons for ships of this class, which approaches the displacement of old-time frigates; our *Constitution* had 2,200 tons, but was a large and heavy ship of her class.

The new arrival in the field of naval warfare is the submarine, which is even considered by some as a rival to the armored battleship. In 1897 a Holland submarine, 55 feet long and propelled by a 50-horsepower gasoline (petrol) engine, was launched at Elizabethport; this was a small, low-powered boat compared with contemporary submarines built in France, where these craft were first developed in practical form. Even in 1903 the boats for our navy were small and feeble, such as the *Pike,* which is 63 feet long and has 160 horsepower when running at the surface, which gives a speed of 8½ knots. Submerged she makes only seven knots. Submarines building are reported to have 525 tons displacement, with speeds of 14 knots at the surface and 9½ immersed. Great Britain reports submarines of 800 tons displacement to have 15 knots speed, and larger boats are said to be contemplated. That such craft will greatly increase the difficulties of a blockading fleet and add to the nervous strain of the commander will be certain; they may render inclosed areas and all spaces near the land untenable for battleships on account of the discrepancy of the cost of the submarine and its natural prey, the large armored ship. This will increase the importance of the destroyer, which will be unlikely to give place to any craft which is not larger nor more expensive. The consequence is likely that important naval engagements will be in the open sea, where the advantage of large ships and big guns can be best developed.

LESSONS FROM RECENT NAVAL BATTLES

During our fifteen years there have been two naval wars, a little one of our own and a large one in the Orient. Both exhibited the fact that however costly preparation may be, lack of it is vastly more costly, and that the most wasteful course of all is to go through the form of preparation without the spirit that makes it effective. There is much to learn from the ships which went into action in these wars, but, aside from the lesson just indicated, this information relates mostly to the effect of gun-fire, which could have been learned by firing at condemned ships, as has been done both before and since these wars. The drift toward big guns only began before the more recent of these wars and has been little influenced by it.

A lesson that should be taken to heart is the futility of trying to improvise a naval force, or any part of such a force, after trouble begins. This lesson is the most important for us because the exigencies of a new country have bred the habit of getting along with inadequate means, and because we have twice had the good luck to do just what is here inveighed against. In 1861 the South had no navy and no means of building one; anything that could float a gun might serve a purpose. In 1898 the enemy was in much worse condition than ourselves.

Let us take a glance at the efforts at improvisation when last tried. The government bought two cruisers, a gunboat and two torpedo-boats; the cruisers (though different from what we should have built) are still in service, having both speed and gunpower; the other craft are happily forgotten. But, after all, buying warships at a pinch is all right; how about the non-military ships? A rough count shows that the government bought or chartered about 30 ocean steamers, 20 tugboats and 25 yachts. All the ocean-steamers were needed for transports and for other purposes and the four 20-knot Atlantic liners were invaluable; our only regret was that we had not more and better.

The tugboats and yachts were given such light guns as could be found and fitted, and were called auxiliary gunboats; against an active foe they would have been unable to fight or to run away. Our sailors handled them gallantly and, as on the *Gloucester* at Santiago, added luster to our naval fame; another time the same gallantry could be expected to yield nothing but bitter loss and shame.

RECENT AIDS TO NAVIGATION

Three notable aids to navigation and to safety at sea are wireless telegraphy, submarine signaling and the gyro-compass. Each should receive a whole paper for adequate description, instead of the bare mention now possible. The first appeals at once to everyone, especially as a means by which a ship in distress may call for aid. Its importance to the warship is even greater, but a disadvantage which is not commonly known to the casual reader is illustrated by the fact

that Russian cruisers habitually detected the neighborhood of Japanese vessels by picking up messages, some of which they could read and others not.

When the navigator approaches a shore in the fog he can only feel for bottom with the lead line and listen for fog signals. The first is sure but indefinite; the second can be made definite, but it is elusive. The writer was one of a party that came up toward Boston light on a fair day when the great foghorn was sounding; each blast was betrayed by a puff of steam; as we came up, the blasts could be heard distinctly, till we came slowly on the lighthouse tender to a certain limit, beyond which the sound disappeared and we could see but not hear each blast on the horn. The submarine signal struck on a submerged bell does away with this uncertainty, for the denser fluid is not affected by dead-spaces and ghosts. The navigator can pick up the sound in a special telephone receiver and can judge both the distance and direction of the bell; if he hears two bells he can triangulate for his position.

"True as the needle to the pole" is good poetry but poor navigation. The navigator's motto is "When in doubt, distrust the compass." The two evils that beset the compass on a steel ship are variation of the magnetic meridian and deviation due to the magnetic action of the steel of the ship itself. The importance of magnetic surveys is indicated by the fitting of the non-magnetic auxiliary brig *Carnegie,* built of wood fastened with bronze, and provided with copper and bronze propelling machinery. But important as magnetic surveys may be, it is not the variation that worries the navigator, because it changes regularly and slowly, but the deviation which is full of vagaries. A captain of a coast-wise steamer told the writer that lying two or three days at the dock in Baltimore developed enough temporary magnetism (if not allowed for) to throw him out of the channel on the way out. It is notorious that after target practice on a man-of-war all compasses are liable to complete derangement; after an action the most reliable compasses on bridge and superstructure would be liable to be swept away.

The gyroscope-compass, which depends on Foucault's principle, is actually true to the pole, and always points to the true astronomical North. This compass carries a swiftly rotating gyroscope or flywheel with its axis hung horizontal in gimballs. Under the influence of gravity this axis swings into the true meridian and is uninfluenced by magnetism or any other extraneous influence. Once properly adjusted it requires no other attention than to keep the machinery for spinning it in good condition. Since the compass is expensive and somewhat heavy, only one master compass is installed in a safe and convenient place below decks; repeating compasses, controlled by electric transmission, can be placed as convenient on the bridge and in the wheelhouse. These compasses will become necessities for warships and on all large and important ships.

Application of Electricity to Hull Auxiliaries

All large ships have extensive electric equipment, so much that the electric elevator (lift, on English steamers) is familiar on the Atlantic liners. Warships have electric ammunition hoists, and turret-turning machinery and elevators from the fireroom. But the anchor-gear, the steering-gear and deck winches are still worked by steam, and electric gear for such purpose are but now forcing their way into service. To provide for steam gear it has been necessary to carry a steam main right forward and aft; and this steam main is expensive, wasteful and troublesome; when below decks it is apt to be uncomfortably hot. Now the anchor engine may be brought up standing when the pull on the anchor chain exceeds a computed amount, without danger of carrying anything away; when the strain is reduced the engine starts up again; the deck winch behaves in the same way. In a word, the torque is constant. On the other hand, the tendency of the ordinary electric motor is to increase the torque as it slows down, so that early deck winches habitually broke the lines. As for the steering-gear, it must follow the wheel in the hands of the steersman, and at the same time have such elasticity of action that the rudder may yield to the blows of the sea and yet automatically return to the proper setting. The delay in the introduction of the electric gear is due in part to the peculiarities of the service and in part to the failure of electricians to appreciate them.

Ventilation

If the sea were always smooth all would be good sailors, but in bad weather the motion of the ship and lack of ventilation are liable to be simply nauseating. Now the path of the ventilating engineer, even ashore, is strewn with ambitious failures, and the difficulties of overcrowding and high winds at sea are many-fold more difficult. This explains at once the high prices demanded and paid for deck staterooms where ports may always be opened. The best success at sea is by aid of numerous separate systems which may distribute fresh air, warmed, if required, to restricted spaces. The *Olympic* has seventy-five electrically operated fans, some working under pressure and others exhausting foul air.

Anti-Rolling Devices

In a general way the big ship is less easily thrown about by the sea, and that is one reason for the favor in which it is held; but the largest ship must yield especially to waves that have the right period. Now the ship has two motions, pitching and rolling. As for pitching, the mind of man has devised no remedy; the passengers may draw as far as possible toward the middle of the ship and then they may even take what comes. But rolling may be largely controlled by making the natural swing of the ship slow and gentle. Contrary to a natural idea, it is the tender ship rather than the stiff ship that is steady. Bilge keels also help to check the rolling, though they add to the power demanded of the engines. Small ships, like channel steamers, cannot be made tender enough to check rolling without undue danger, and for them Schlick's application of the gyroscope on a relatively large scale has been found efficacious, especially in reducing the regular rolling due to waves which have the same period as the ship. The recent big battleship, with its enormous battery carried over the decks, also must have considerable stability, and is liable to be a quicker roller than some of the older types. The proposition to apply gyroscopes to them brings in special engineering difficulties because they involve considerable weights, high speed and heavy-bearing pressure. An alternative proposition is the use of quieting tanks, as once used in a cruder form on the old central battery armored ships. Two tanks are installed, one on the port side and the other on the starboard, with communicating passages nicely adjusted, so that as the ship rolls the water shall always be found on the down side ready to resist the heave of the ship. The application of such devices is likely to be limited because the steadiness and comfort of large ocean passenger ships are now very satisfactory.

Two Russian cruisers, each 266 feet 8 inches long by 42 feet 2 inches beam, of about 3,500 tons net and 1,200 horsepower, have been fitted with Diesel engines by one of the leading marine engine builders in that country. This firm has also furnished Diesel engines for five 1,000-horsepower gunboats, one 900-horsepower gunboat, one 750-horsepower government inspection ship, together with other craft, which brings the total up to 90 ships aggregating 20,000 horsepower.

Progress in Marine Engineering During the Past Fifteen Years

BY DR. W. F. DURAND

The past fifteen years has witnessed in all branches of engineering and industrial art a development and progress probably unparalleled in the same period of time hitherto. In no branch is this perhaps more true than in marine engineering, and in the present article an effort will be made to note and evaluate the more important items and features which have, during this period, characterized the progress in this particular field.

Fuel

Coal has remained throughout the period the dominant fuel in the marine field, though there has been a significant and progressive increase in the use of liquid fuel, either crude petroleum or residues after partial distillation. The possibilities of oil fuel in the field of marine engineering began to attract the attention of engineers during the decade from 1880 to 1890 and in the Congress of Engineers, held at Chicago in 1893, an important paper was read by Colonel N. Soliani, of the Royal Italian Navy, setting forth the practice at that time and the results of experience in which the Italians had taken the lead. Further experience was gradually accumulated and the use of oil extended slowly, until, in the later years of the decade 1890-1900, the principles governing the effective use of oil as a fuel had become fairly well established and further and more rapid extension in its use became dependent on economic conditions of cost and availability rather than upon the engineering problem of its efficient use. Since those years and down to the present time progress has been along the same lines. Further study has added to our understanding of the conditions necessary for the efficient combustion of oil fuel as an engineering problem, and at the present time this phase of the question may be said to have reduced itself purely to one of minor mechanical detail. At the same time the discovery of new oil fields, increase in production, improved methods of handling, transportation and storage; these, combined with the economic possibility of placing it on board a steamer at a price which will compete satisfactorily with coal viewed simply as a means of producing steam; these various facts have all combined to widen in marked degree the progressive use of oil as a marine fuel.

At the present time the United States navy stands committed to the definite use of oil as a fuel for both battleship and torpedo-boat types; several lines of steamers plying on the Pacific and elsewhere are committed to its use either exclusively or in large part, while it forms naturally the fuel used by the large and ever-increasing fleet of steamers engaged in the oil trade itself.

A typical present specification for oil fuel is as follows:

Gravity, degrees Baumé	15 to 18
Weight per barrel of 42 gallons	336 pounds
British thermal units per pound	18,500
Moisture, not to exceed	2 percent
Sulphur, not to exceed	5 percent
Flash point, degrees Fah., not below	200

The principles and methods of fuel oil combustion have received such full attention in the engineering press that in the present article there is no occasion for more than such brief mention as will serve to mark out the chief lines of progress during the past fifteen years.

Speaking broadly the general conditions for the efficient combustion of oil fuel are as follows:

(1) The introduction of the fuel into the furnace as a vapor or in such a finely divided spray that its passage into the condition of vapor will be practically instantaneous.

(2) The intimate mingling of the vapor thus formed with air sufficient for complete combustion.

(3) The production of this mixed vapor and air at the highest practicable temperature previous to ignition in order that the minimum heat may be taken from the furnace for the elevation of such mixture to the point of ignition.

(4) Suitable dimensions and volume of the furnace in order that the combustion may be practically completed before the gases enter in or among the tubes.

The following general features are characteristic of the best present practice with oil fuel, the relation of which to the general principles above noted will be, for the most part, plainly apparent.

(1) Settling tanks to allow water and sand to settle out, so far as the gravity may permit, before going to burners. Present specifications for fuel oil usually fix the water content at not exceeding 2 percent, and in such cases gravity settling will effect little further. If drawn from near the bottom of storage tanks, however, or in case double bottoms are used for extra or reserve storage, water in greater proportion may be present and settling tanks are requisite. They are preferably fitted in duplicate so that one tank may be settling while the other is furnishing the oil for current demand.

(2) Means of heating the oil to insure fluidity at the burners, to facilitate the transformation of oil spray into vapor and to furnish such vapor at the highest practicable temperature, independent of direct demand on furnace heat. Such heating is usually furnished by exhaust steam coming from the pumps mentioned in (3). The permissible temperature of the oil depends on the gravity and flash point. With standard grades with moderately high flash point the temperature may safely approach 200 degrees Fahrenheit. Temperatures too high tend to develop a deposit of carbon on the oil-heating surfaces.

(3) Oil service pumps for handling the oil from storage to tanks and thence to the burners. The delivery line to burners should be fitted with strainers in duplicate so that all solid matter may be removed and the danger of clogging the burners may be minimized. With such strainers in duplicate with appropriate shut-off valves, either may be cut out and cleaned while the other is in service.

(4) Means for atomizing the oil and introducing it into the furnace with sufficient air for combustion. For effecting atomization three means have been employed—steam, compressed air and mechanical means.

Steam atomization involves the waste of fresh water by way of the smokestack, and this constitutes a heavy drain on the make-up feed supply. For this reason steam atomization is commonly restricted to inland waters or to short trips. The steam pressures employed range commonly from 60 to 80 pounds, combined with somewhat similar or slightly lower pressures on the oil line.

Air for atomization is applied at pressures all the way from one pound to 60 or 80 pounds, according to the system employed, combined with suitable pressures on the oil line.

With mechanical means of atomization the oil pressure maintained must be adapted to the characteristics of the system.

(5) Furnace arrangements, including means for admitting

the right amount of air, distributed in accordance with the needs for complete combustion, and also such dimensions and proportions of furnace and such distribution of fire brick for radiation purposes as shall insure completed combustion before the flames come into direct contact with the heating surfaces of the boiler.

With Scotch boilers the furnaces are usually too small for best results. This boiler as a type has been developed with special reference to coal fuel. To realize the best results, the entire boiler design should be developed with reference to oil fuel. With watertube boilers desirable furnace volumes and proportions are more readily realized than with boilers of the Scotch or internally fired type.

The chief advantages which may properly be claimed for oil fuel are as follows:

Labor is saved in the fire-room; the coal passer is practically eliminated; the thermal efficiency of a boiler with oil fuel is higher than with coal, and in consequence of this and of the higher heat value per pound the evaporation of steam per pound of fuel is greater for oil than for coal in the ratio of about 10:7; oil per ton occupies less space than coal in the ratio of about 9:11; oil is cleaner than coal as regards the absence of ashes and of dust in fueling ship; under proper conditions of use the cost of maintenance of boilers with oil fuel is less than with coal; oil can be handled mechanically, and with proper facilities more expeditiously than coal, thus saving time in fueling ship; oil stows more readily than coal, and otherwise unavailable spaces may be used for oil tanks, and it may be carried in double bottoms if necessary.

The chief disadvantages which have been urged aside from the question of economic price may be summed under the heads: noise, odor, danger. All three are under definite and satisfactory control. The latter, which is the only one of importance, calls for intelligent use in the furnaces, for suitable provision regarding means for ventilation of oil tanks, and for specially good riveting on all joints which are intended to be oil-tight.

Extended test and experience show that economically 1 pound of good fuel oil with a boiler economy of about .75 will evaporate under average actual conditions about 13 pounds of steam. This will correspond with good engines to a horse-power-hour for from 1 to 1.25 pounds of oil. It will readily appear from these figures, compared with the corresponding values for coal fuel, that having in view fuel costs alone, the two fuels will represent equal steam-producing value when the cost of coal per ton of 2,000 pounds is about 4.1 times that of oil per barrel of 336 pounds. With a relative cost near this value or slightly higher, there will be undoubted over-all economy in the use of oil fuel.

The use of a certain percentage of the steam or its equivalent energy in compressed air for purposes of atomization has stood from the first as a heavy tax on the economic results available with oil fuel. The amount is rarely less than 3 to 4 percent, or about ½ pound of steam per pound of oil. This means the reduction of a gross evaporative efficiency of, say, 75 percent down to 72 or lower. In the past few years increasing attention has been given to the development of mechanical forms of atomization, some of which have shown results corresponding to a steam consumption not exceeding 1 percent of the boiler output. The possibilities of this form of atomization represent perhaps the most significant feature in the present trend of progress, and should receive the careful attention of engineers who are contemplating the use of oil fuel.

Boilers

During the decade 1890 to 1900 the watertube boiler made continuous and increasing gains in the field of marine engineering, a field which it had definitely begun to share with the older fire-tube types during the preceding decade. By the close of the century it had acquired practically complete possession of the field of small craft, and in particular where saving of weight and high speed were distinguishing features. In the field of naval design this included the launch and torpedo boat, and in some few instances watertube boilers of the Belleville form were installed in ships of the cruiser type and also in certain vessels in the merchant marine. The older Scotch form of fire-tube internally-fired boiler remained as the dominant, or practically the only type throughout the remainder of the field, including with few exceptions all naval vessels of the cruiser and battleship class, and the wide field of mercantile steamers of all sizes and types from the ocean greyhound to the humble tramp.

During the period which has elapsed since those years the chief field of change has been that of naval design. At the present time, the world over, warships of all types and sizes are fitted, almost without exception, with boilers of the watertube type, while in the wide field of the mercantile marine the Scotch boiler still remains dominant, although even here the watertube boiler has made some notable gains.

The distinguishing features which have determined this steady growth in favor, especially in the field of naval design, are (1) saving of weight due to decreased amount of water in boiler; (2) greater capacity for forcing, especially in the so-called express or small tube forms; (3) greater flexibility in service, permitting rapid raising of steam, or, in general, rapid variation in rate of output as required by rapidly varying conditions; (4) relative safety from results disastrous to the ship in case of explosion.

Certain of these characteristics have at the same time necessarily entailed consequences which have operated to retard a correspondingly rapid extension of favor in the mercantile marine. These are (1) the reduced amount of water, requiring much closer attention to the feed and greater sensitiveness to variations in regimen, or, in general, to the conditions of service; (2) greater cost of upkeep than for fire-tube boilers, more particularly in certain of the earlier types where the features of design were less perfectly adapted to the conditions of service than in the later forms; (3) the demand in general for a higher grade of intelligence for their efficient management and care than in the case of fire-tube boilers. This argument has become gradually of decreasing importance, due to a continuously growing familiarity with such boilers among firemen and water tenders in general, and due to improvements in design and in fittings which have aided in bringing such boilers under more definite and reliable control.

Watertube boilers have been classified according to all varieties of characteristics. Thus we have had boilers with straight tubes and with curved or bent tubes; boilers with continuous or unbroken elements and with elements made up of screwed joint connections to drums or headers; boilers with outside down-flow and with inside down-flow; boilers with large tubes and with small tubes; boilers with tubes nearly horizontal or nearly vertical or at some other more or less definite angle; boilers with the upper ends of steam forming tubes flooded and boilers with such tubes dry; that is, discharging their contents of mixed steam and water above the water level. In addition, the combinations of tubes with drums or drums and headers have been worked out with a most bewildering variety of geometrical form and mechanical connection. Out of this variety of form, which perhaps was at its height in the early years of the period under consideration, have come a few fairly well defined types or forms which have demonstrated general superiority and efficiency for the particular class of service in which they are employed.

Thus in the field of the small fast steam launch, fast steam yacht, torpedo boat and destroyer types, and in general wherever the combination of minimum weight of machinery and maximum speed are distinguishing features, the accepted

and standard form of watertube boiler is represented by the small tube or express type. Boilers of this type, represented by the Thornycroft, Yarrow, Normand and Mosher forms, include some combination of upper or steam drum with lower or feeder drums through bundles of steam-forming tubes, usually from 1 inch to 1½ inches in diameter and straight or curved according to the characteristics of design. Such boilers according to the degree of forcing will furnish from 8 to 10 or 12 pounds of steam per square foot of heating surface, and will weigh with water about 1 ton per 60 to 100 indicated horsepower developed with good triple-expansion engines. Such boilers commonly carry steam pressures from 250 to 300 pounds, and are provided with steam drying or steam superheating coils or pipes in varying degrees. On the other hand, for naval ship or cruiser and battleship types, and in the mercantile marine where watertube boilers are employed, practice is divided between the small tube type as above and the large straight tube type, of which the marine Babcock & Wilcox form is perhaps the most widely used and most typical of present-day practice in this field.

The tubes in such boilers are from 2 to 4 inches in diameter, and are connected by means of headers or manifolds to a suitable upper or steam and water drum. Such boilers under moderate forcing, such as is intended for normal service in this field, will evaporate from 5 to 8 pounds of steam per square foot of heating surface, and with water will weigh 1 ton per 25 to 40 indicated horsepower developed with good triple-expansion engines. Such boilers carry steam pressures from 200 to 250 pounds, and are occasionally associated with superheater elements or specially fired superheaters for drying or superheating the steam to a point depending on the character of the prime mover, whether reciprocating engine or turbine.

There has been an insistent demand throughout the period under consideration for improvements in economy in all branches of engineering. Conservation of natural resources, scientific management and other allied movements are all expressions of the same fundamental demand. In the field of marine engineering these considerations have exercised a profound and determining influence, and it is not too much to say that the chief progress in connection with the steam boiler during the past fifteen years has been in connection with considerations bearing on the general problem of operative economy. The marine boiler in general necessarily suffers somewhat in this respect in comparison with the typical stationary power plant boiler. This is due to two primary causes: (1) The marine boiler must of necessity be worked at a rate of output per square foot of heating surface from two to four times that of the stationary boiler; (2) the setting can rarely be made as effective against radiation losses in the case of marine as compared with stationary boilers. Both of these limitations trace back to the marine requirements of weight saving, and due to their influence it can hardly be expected that a sustained boiler efficiency, even on large ships and where the conditions are only moderately severe, can much exceed 75 percent, while under severe forced conditions, as on vessels of the torpedo boat or destroyer types, the value will naturally fall considerably lower. These values are 5 to 10 percent lower than those attainable in stationary practice, and this handicap the marine designer must, as a rule, accept as a consequence of the controlling conditions of his problem.

The conditions for the highest boiler economy are in brief: (1) To maintain continuously the conditions for complete and perfect combustion; (2) to supply the minimum weight of air per pound of fuel consistent with (1); (3) to deliver the resultant furnace gases to the stack at the lowest possible temperature; (4) to reduce to the lowest possible minimum all radiation and like secondary losses. Requirement (3) in particular is inconsistent with forced conditions or a high rate of output per square foot of heating surface. Much, however, has been accomplished along these various lines. In order to satisfy condition (1) the introduction of the fuel and air into the furnace should be continuous and regular. This is a distinguishing feature connected with the use of oil fuel, and is in no small degree accountable for the increase in efficiency with oil as compared with coal. Much, however, can be accomplished by light, frequent systematic firing, and the system of "clock-work" firing which has been introduced into the naval service shows what may be done by way of improvement over the older "hit-and-miss" method. The excess supply of air is usually estimated by means of some of the many forms of CO_2 indicators or recorders. These are not in as common use in the marine as in the stationary fire-room, but they are attracting favorable attention, and point the way toward at least one method of securing better control over the irregular variations to which the air supply is commonly subject. The use of feed heater elements and the more intelligent distribution of baffles for securing effective distribution of the gases in the case of watertube boilers are all working toward a lower ultimate stack temperature, and toward saving at this important point of heat loss.

In this general connection reference may be made to the astonishing results which have resulted in the naval service from the introduction of the competitive idea, combined with the intelligent appreciation of these fundamental principles of economy. Savings in the most marked degree have been realized by the simple combination of brains with the resources of the engineering world. Results such as have been thus accomplished show plainly the possibilities of improvement, and mark the pathway along which further effort should be made.

Notable progress has also been made in the further study and better understanding of the conditions affecting general upkeep, especially those related to chemical corrosion and to scale formation. In particular, the status of fresh water as the only acceptable feed for marine boilers, no matter what the type, has been established, and the evaporator or some equivalent make-up provision for feed water has become a definitely accepted feature of marine design.

Superheating coils or other equivalent means of superheating the steam have become an accepted feature of marine design where turbines are involved. There has been, however, no great advance in the use of superheated steam otherwise.

Recent lines of development in connection with the marine boiler have thus centered about the following points: Minor improvements in detail and in connection with the conditions of operation of the Scotch boiler; try out and elimination among the various types of watertube boilers; special study of the conditions affecting economic performance and cost of upkeep in the marine fireroom in general.

Whatever the lines of development in the near future, it is sure that the latter will constitute a continuing subject for careful study and that not the least contribution of the past fifteen years in this field of engineering practice will be the definite recognition of the high importance of such considerations and the good start which has been made in bringing them under definite engineering control.

The Reciprocating Steam Engine

Fifteen years ago the reciprocating steam engine was practically undisturbed in its possession of the field of marine engineering. The marine steam turbine had barely appeared above the horizon in the performance of the *Turbinia*, the gasoline (petrol), naphtha and alco-vapor engines were attracting attention for launches and similar small craft, and storage battery electric propulsion had shown some hopeful possibilities for moderate speeds and under special conditions of operation. With these unimportant exceptions the reciprocating engine was the only form of prime mover which could

have received serious consideration at this period. At the present time, while it still remains dominant in the field, nevertheless the steam turbine and various types of internal-combustion engines have made such progress in demonstrating their adaptability to the demands of marine propulsion that it requires no serious stretch of the imagination to forecast the possibility of its decline and possible disappearance in a not far distant future.

The reciprocating engine representing in effect the results of two centuries of development as a prime mover and of almost one century in the field of marine practice had attained at the beginning of the period under present examination to a finished and indeed almost final stage of development, at least as far as its main characteristics were concerned. Such engines were available in units of any size from one horsepower to ten thousand horsepower and upwards, prevailing piston speeds varied from 300 or 400 to 1,000 feet per minute, and revolutions per minute from 20 or 30 for paddle-wheel engines up through 60 to 100 for large screw-propeller engines to 400 and more for torpedo craft, and, in some cases, to 800 or 900 for special racing-craft designs. The problems which were challenging the attention of the marine designer at the beginning of this period related largely to the question of the number of stages for expansion, whether triple or quadruple, and to the number and distribution of the cranks with reference to balance and to the general problem of engine balance and ship vibration, which had been forced into prominence by the rapidly increasing demands for speed and the correspondingly increased amount of power per ton of ship structure. These are problems that seem to have been satisfactorily solved.

The lines of development during the fifteen-year period since have been concerned chiefly with the further study of the fundamental problem of balance and vibration, and with the more perfect adaptation of the engine to the demands for size or for power in relation to weight, which have continuously increased throughout the period. The problem of balance and vibration has been brought well into hand. The causes of ship vibration are well understood in their genesis and the various ways and means available for balancing the periodic inertia forces of the moving parts are well understood by marine designers. Within reason the problem of engine balance as a factor in ship vibration may be considered as having reached a final solution, and this achievement must be counted as one of the important contributions of this period to the science of marine engineering.

There have been also ever insistent demands for units of larger size, for less weight per unit of power developed, for greater reliability of lubrication, and in general for such a readjustment of the relation between the conditions of operation and the characteristics of design as shall secure a continuously rising economic result. There has been an answering and effective effort on the part of designers, and definite progress has been made toward improved overall reliability and economy.

The marine reciprocating engine of the present day may perhaps claim to be a finished engineering product so far as it presents a particular solution to the problem of marine propulsion. It is not implied that it presents necessarily the best solution, but, taking the solution which it does present, and viewing the demands of the problem, the conditions of operation and the present resources of the engineering field, the marine engine as a type may claim to represent as nearly a finished engineering product as human effort may presumably hope to achieve. This means that within this type only such improvements will presumably become possible as may be permitted by further advance in the physical and engineering qualities of the materials of construction which will reduce the weight of the engine and enable it to take care of higher temperatures.

The Steam Turbine

Complete and as nearly final as is the reciprocating steam engine within the limitations of its own type of design, there are at least four points of fundamental importance regarding which the steam turbine, by reason of its different design, is able to offer superior advantages. These are (1) saving in weight; (2) saving in space occupied; (3) entire absence of reciprocating parts and, hence, of vibration-producing forces so far as the prime mover itself is concerned, and (4) lower center of gravity. Among secondary advantages may be mentioned absence of internal lubrication and consequent freedom of feed water from oil, indifference to conditions liable to produce racing, indifference to priming of boilers so far as safety is concerned, and high overload capacity provided the boilers can supply the necessary steam. These various advantages are not, however, purchased except at the cost of some limitations and disadvantages. The more important of these are (1) the impossibility of realizing a reversing turbine except through the provision of a special reversing section, thus making in effect two turbines, one for going ahead and one for backing, either of which must necessarily be inoperative while the other is in use. This condition has resulted in the provision, as a rule, of less power for backing than for going ahead, a condition which limits somewhat the elements of control and maneuver; (2) the high shaft speed which is necessitated by the turbine design and the consequent difficulty in realizing the best proportions of the propeller for efficiency, and resulting in a definite loss of propulsive efficiency; (3) the fact that the efficiency of a steam turbine is closely connected with the speed and necessarily falls off seriously at reduced speeds. This feature becomes of serious importance in naval design where widely varying speeds must be counted as one of the normal conditions of operation; (4) the fact that the economy of the turbine is more dependent on size than with the reciprocating engine, and the consequent poor showing in economy for turbines in small sizes and for small craft.

In order to avoid the losses which arise, due to the high good efficiency speed for the turbine, and the much lower good efficiency speed of the propeller, certain forms of reduction gear have been employed between the turbine and propller shaft, in particular the Parsons reduction gear, which has been tried out on the steamer *Vespasian,* and the Melville-Macalpine gear, which has been installed on a United States collier. These are special forms of spur gear reductions, the use of which will allow the turbine to run at a high speed and the propeller at a much lower speed, thus placing each in the range of speed suited to its best efficiency. The mechanical efficiency of the Melville-Macalpine gear has been shown to be very high, not far from 98 percent, and with the improvement in the efficiencies of both the propeller and the turbine the result should show a definite improvement in overall propulsive efficiency. Further tests will show to what extent such forms of reduction gear are likely to form a permanent feature of turbine drive installations.

At the present time the turbine has achieved a genuine success with high-powered steamers of the ocean greyhound or fast passenger type. It has not met with equal favor for freight steamers, especially in the vast field of the moderate size, moderate speed type. It has met with success and favor for river steamers or other like craft of relatively shallow draft and high speed. It has met with favor in the field of the large fast yacht, but not similarly for small yachts and pleasure craft. It has been given extended trial for naval service by all the leading naval powers, and with somewhat divergent results. It has been used in torpedo boats, destroyers, torpedo gunboats, scouts, cruisers, armored cruisers, battleships and battle cruisers. While its limitations have been recognized, the general trend of practice during the past ten years has shown a marked increase in the use of the turbine.

In the United States navy, however, the most recent battleship designs show a departure from this trend and a return to the reciprocating engine. Experience of the most valuable character has been gathered as the result of the competitive trials and service of the three scout cruisers *Birmingham, Chester* and *Salem,* and of the two battleships *North Dakota* and *Delaware.* Limitations of space prevent any reference to the results in detail, but they have been widely published in the engineering press and show in effect, at least in these instances, that (1) the turbine has a very limited range of speed for good economy and that over a wide range of speed the economy of the reciprocating engine is superior; (2) the turbine seems more difficult, under the conditions of naval service, to keep in a state of readiness for operation, the cost of upkeep is higher and in many ways its adaptation to certain conditions of the service is distinctly inferior to that of the reciprocating engine. For these reasons in chief, the United States naval designs have returned to the reciprocating engine in the latest battleship designs. Further experience alone can determine whether this reversion is anything more than temporary.

The characteristics of a modern turbine installation are, briefly, as follows:

(1) Boilers giving either saturated or superheated steam according to choice with the particular turbine. Marine turbines of the Parsons type do not as a rule use superheated steam. Turbines of the Curtis and allied types, where the steam passes through expanding nozzles before entering the blading, commonly use steam superheated in some degree.

(2) The turbine itself. The types used in the United States are of either the Curtis or Parsons-Westinghouse types. In England, the Parsons is the favorite type; and in Continental Europe, Parsons, Zoelly and Rateau types are used.

(3) The condenser and air pump. The turbine has been found to be especially responsive to improvement in the vacuum. Whereas with the reciprocating engine the gain in economy for a vacuum beyond about 26 inches has been found to be small and of questionable amount compared with the expenditure required to realize such value, the same is by no means true with the turbine, and distinct gains are realized up to 29 inches or to the highest values which are practicable. The condenser and air pump equipments for a turbine installation are therefore much more important relatively than for a reciprocating engine. A very considerable increase in the cooling surface in the condenser must be provided, and a greatly increased capacity in the air pump. Due to these facts the typical turbine installation will occupy nearly as much floor area as the reciprocating engine, though some space vertically may possibly be saved, especially in warships, where every odd corner and pocket may have its value.

On the whole, the progress of the steam turbine as a marine prime mover has not perhaps been quite as rapid, and its acceptance has not been as general as might have been expected from its early promise. Even in the field where it has achieved its greatest success, that of the ocean greyhound, as evidenced in the *Lusitania, Mauretania* and others, the reciprocating engine still retains a strong hold on the practice of the day. The ultimate solution of the problem of the marine prime mover is perhaps not yet in sight. We are now in a period of transition or of elimination, and as a result of the movements and tendencies which are now going on we may well look for some more definite determination, at least as between the reciprocating engine and the turbine, as to the particular types of service for which one form or the other is best adapted.

TURBO-ENGINE DRIVE

As a form of compromise, or as an attempt to realize the good points of each type of prime mover, designs have been developed especially for warships and carried out in several instances, involving the combined use of both the reciprocating engine and the turbine. Such designs have sometimes included three shafts, the two outer or wing shafts driven by turbine and the center shaft by reciprocating engines. When going at moderate speed the engine alone is used, the other propellers revolving freely with their shafts and connected turbine rotors. When going full speed all three are used, and under an intermediate condition the turbines might be used alone with the center propeller shaft disconnected from the engine and revolving. In other cases both turbine and engines have been installed on the same shaft, the former turning freely when the latter only are used. In other cases, as with the *Olympic* and *Titanic,* the two wing shafts are driven by engines exhausting at about 9 pounds absolute into a low-pressure turbine driving the center shaft.

In still others four shafts are used or proposed, the outer or wing shafts for reciprocating engines and the inner for low-pressure turbines using steam from the engines.

It is a fundamental fact that the reciprocating engine is the better adapted to realize full benefit and economy from high steam pressures, and in general from the upper part of the total expansion range of steam, while the turbine in peculiar manner is suited to realize the best results from a diminished back pressure and in general from the lower part of the range of steam expansion. It is this fact, coupled with the divergent relations of the two forms of prime movers to speed variation, that have led to the effort to find the best over-all result in some combination of the two. The results in many cases of such mixed installations have been reported as highly satisfactory. Further experience will be required to determine the exact types of combination best suited to the various demands, or whether such combinations are more than a passing phase in the trial of elimination among the various forms of prime mover which are now presented for the consideration of the marine engineer.

ELECTRIC PROPULSION OR ELECTRIC DRIVE

Electric propulsion may be viewed either as a means of directly applying electric energy drawn from a storage battery or other suitable source to the propulsion of a ship, or as a form of drive intermediate between a steam prime mover (such as a turbine) and the propeller shaft.

Electric motor boats driven by energy from storage batteries were a feature of the Chicago Exposition in 1893, but the development along this line has been rather sharply limited, due to weight and other characteristics inherent in present forms of storage batteries. This particular form of drive has, however, received a notable and important application in the operation of submarines. This form of power application, introduced near the close of the last century, has received close study and important development during the past decade, so that to-day it stands as the typical form of power drive for submarine boats when navigating under water. A typical installation includes gas or oil engines, storage batteries and an electric unit which may at will be used as generator for charging the batteries or as motor to transform the energy so stored into propulsive form. While navigating on the surface or when the exhaust from the engine can be rejected to the air, the internal-combustion motor is used, a part of the power so developed being employed to operate the electric unit as a generator, and thus to charge the batteries if necessary. Otherwise, disconnecting clutches provide, while the boat is at rest or at anchor, for operating the engines for the same purpose. When the boat is navigating below the surface the engines are disconnected, and the energy is drawn from the batteries and transformed by the electric unit acting as a motor into propulsive work.

This scheme of submarine drive, which has reached a state of high efficiency, represents in all its present essential details

of growth and perfection an engineering product of the period under present review.

Turning to the other aspect of an electric drive, we may at the start note that the utilization of the combination of electric generators and motors between a steam prime mover and the propeller shaft is most consistently viewed as a means of speed reduction or, in general, of speed change. While for many years suggestions and plans have been brought forward more or less vaguely regarding the utilization of such a type of drive, it was reserved distinctly to the period covered by the present review, and to the last few years of that period, to bring such drive into practical form. The development of such a form of electrical drive may be viewed as the direct result of an effort to meet the limitations of the turbine with reference to reduced propulsive efficiency at the initially high speeds and loss of economy in the turbine at reduced speeds. These points have already been noted in connection with the turbine. The answer which the electrical drive offers is to interpose between the steam turbine prime mover and the shaft an electric generator-motor combination as a speed reduction device. This provides in the first place for a moderate and efficient speed for the propeller shaft at full speed, or in general for such speed of shaft as the propulsive conditions may demand for the best combination result. Next, by providing a step-speed induction motor with speeds, for example 60 and 100 percent of full speed, and by the use of resistance for reversing and of direct speed change in the turbine over the step intervals, a combination is achieved which allows the prime mover to run nearly uniformly at its normal high speed with moderate speed changes for maneuvering, and for motor speeds intermediate between those normally given by the pole number combinations. The motors may be stopped, reversed and started independently of each other and while the generator is running.

Such a general plan has been proposed for battleship drive, and a similar but somewhat simpler installation is at present being installed in the United States collier *Jupiter*, now building at Mare Island, Cal. The steam consumption expected from the proposed battleship installation ranges from 11.3 to 13.4 pounds per shaft horsepower-hour over a range of speed from 21 to 12 knots, while for the collier installation from 10 to 14 knots speed the water rate should range from 15.55 to 12.15 pounds. If these figures are realized even approximately, they will mark an advance over the economy to be expected from a reciprocating engine installation over the same range and under the same general operating conditions, and in still higher degree over that to be expected from a direct-connected turbine installation covering the same range of speed variation.

The Internal Combustion Engine

The internal combustion engine with gasoline (petrol) as fuel had become, by the latter part of the decade 1890-1900, an accepted feature of marine design for launches and small pleasure craft. Since that period it has grown continuously in importance and scope of service and has in fact served as the foundation for an entirely new type of pleasure craft, the high-powered racing motor boat. Parallel with this growth of the gasoline (petrol) motor, the producer gas equipment and motors of the Diesel engine type have demonstrated fitness for service in the marine field generally and are now sharing with the gasoline (petrol) type the serious attention of marine designers for many purposes for which fifteen years ago the steam engine would unquestionably have been employed.

Fifteen years ago the typical gasoline (petrol) motor boat engine was of the two-cycle type, with either one, two or three cylinders, running at three to four hundred revolutions, rarely exceeding four or five horsepower per cylinder and weighing 100 pounds and upward per horsepower. At the present time such engines for marine service are made in both the two and four-cycle types, and with cylinders from one to six or eight for a shaft and developing all the way up to 50 or 75 horsepower per cylinder, running at revolutions from two hundred or less to twelve hundred or more, and weighing down to 8 or 10 pounds per horsepower developed. For convenience of classification such motors are often classed as low speed or heavy duty, medium and high speed, although those classes shade insensibly one into another.

Installations of the low-speed class are by far the most numerous and include the wide field of moderate and low-speed launches, hunting boats, houseboats and pleasure craft in general, with a distinctly significant commercial field in fishing boats and in small river and harbor craft for various commercial purposes. The medium speed or semi-speed installations include more pretentious pleasure craft, small and moderate-sized yachts, passenger and mail boats and similar craft. The high-speed installations belong primarily to the pleasure craft field and represent the utmost that can be accomplished for power on a given weight, all with reference to the highest attainable speeds.

The type of design called for in the low-speed, heavy-duty class is such as will insure the maximum of simplicity and reliability of operation over long periods of time, with relatively cheap and perhaps indifferent quality of fuel, and with such supervision and care as relatively unskilled persons may be able to render. The upkeep in general must also be kept as low as possible, and economy of fuel such as it may be is always a requisite. This will call for conservative design with reference to dimensions and weights, and for the utmost simplicity in construction, combined with assurance of reliability and general acceptable features otherwise. The weight of such designs will usually run from 50 to 80 pounds per horsepower, and the piston speeds from 400 to 700 feet per minute.

In such class of construction for small pleasure launches, skiffs, tenders, etc., for which the power rarely exceeds 12 to 15 horsepower and the periods of continuous operation are always short, and for which fuel economy is often of less importance than first cost, the engines are commonly of the two-cycle type. In larger sizes and for more continuous and harder service, and where fuel economy becomes a matter of larger importance, the four-cycle engine has in recent years compelled acceptance by reason of its superior adaptation to such requirements. Various modifications of the two-cycle type have been tried, looking toward the improvement of the economy by the use of auxiliary cylinders for compression, special scavenging devices, etc., but without notable change in the relative status of the two types. If the two-cycle type is to be improved by further complication of parts it is doubtful if there is any good reason for stopping short of the full four-cycle type of design.

Regarding the number of cranks or cylinders with regard to evenness of crank effort, it may be noted that for the two-cycle type the single-crank engine is occasionally met with in small sizes. The two-cylinder or two-crank engine is, however, much more even in its application of power and is always to be preferred. In still greater degree the four-cycle engine in the single-crank form is unsatisfactory and is never met with in typical modern practice. The two-cylinder four-cycle is equivalent in turning effort to the single-cylinder two-cycle, and still leaves much to be desired in this respect. Three and four cylinders are better, but the standard of smoothness in effort is found in the six-cylinder, four-cycle type, with three sets of cranks at 120 degrees, and in engines of sufficient size to make the four-cycle type of significance this is the desirable crank arrangement.

In the semi-speed or intermediate type there is a higher demand per pound of material, piston speeds are higher and there must be a more exacting and careful design throughout.

At the same time the demands for reliability of operation, expense of maintenance and economy of fuel are substantially the same as in the less exacting type. Weights per horsepower in this class may range from 30 to 40 pounds and piston speeds 600 to 800 feet per minute.

While both the two-cycle and four-cycle types of engine are found in this class of design, the latter seems on the whole to be the more commonly used type, especially in powers above 25 or 30 horsepower.

In the high-speed or racing type everything is sacrificed to the development of the highest power on a given weight. This means the most refined design, reduced factors of safety, the use of materials having the highest possible physical properties as regards strength, resilience, etc., the highest practicable piston speed, and, in general, such combination of factors as will insure for a few hours' time the realization of the maximum possible power out of a given weight of constructive material. Considerations of fuel economy or of the grade and cost of fuel become thus of secondary importance. Reliability for long runs and under varying conditions may also be yielded, as well as relative simplicity and adaptability to unskilled attendance. The piston speeds realized in such engines will range from 900 or 1,000 feet up to 1,300 feet in extreme cases, and the weights will range from 7 or 8 pounds per horsepower for large engines up to 12 or 14 for smaller powers.

The fuel economy of engines of these various types and grades of construction may vary from perhaps .9 to 1 pint of gasoline (petrol). The economy of high-speed boats is better than might otherwise be expected because of the superior grade of gasoline (petrol) commonly employed and on account of the high piston speed.

The character of the cycle of the internal combustion engine, as compared with the steam engine, necessitates several peculiar features of auxiliary design in order to properly adapt it for the requirements of marine service. Thus, for starting in small sizes, the engine may be turned over by hand, the initial charge drawn in, and the start thus effected. In larger sizes, however, compressed air starting has become the rule. For moderate sizes this is effected by attaching to the engine a small air compressor, operated by an eccentric or crank, and provided with an automatic cut-out when the pressure has reached the desired limit of 200 or 250 pounds per square inch. The air thus compressed is stored in lengths of tubing or other form of receiver which can be located in otherwise useless space, and thus becomes available on demand for starting the engine or for blowing the whistle. In large sizes small auxiliary, hand-starting engines are provided, with connections in such manner that they may be used at will for compressing air, for running an electric generator for lights or for pumping.

Another special feature is the reverse. This may be brought about in three different ways. Thus the small-sized, two-cycle units will run in whichever direction they are started, and in this manner by hand the requirements of reverse and control are provided. This method, however, is limited to this type, and to small sizes, and can scarcely be considered as an adequate solution of the problem. For all engines of the four-cycle type the reverse may be effected either by a longitudinal shift of the cam shaft, thus bringing the valves under control of a new set of cams so placed as to determine motion in the reverse direction, or by a gear reverse in the shaft of the planetary type.

About 1905 attention became directed to the possibilities of double-acting gasoline (petrol) engines for marine service, and since that time engines of this type have gained recognition for cases where the power desired per cylinder is more than can readily be developed without undue increase in size. The serious problems of piston-rod packing, internal lubrication and cooling of working parts have been successfully dealt with, and the double-acting type may be considered as the latest product of the past decade in motors of this type.

The engines of the internal combustion type thus far considered have been primarily those using gasoline (petrol) as fuel. Astonishing as the progress has been with engines of this type, the progress during the last few years in the adaptation of oil-burning engines to the demands of marine service has been even more striking. Under this general head brief reference may be made to engines using kerosene (paraffin) engine distillate, and crude oil of various grades and characteristics. Most well-designed gasoline (petrol) engines with appropriate change in the carbureter can be made to run on kerosene (paraffin) or the lighter distillate by starting on gasoline (petrol) and switching over to the heavier fuel. For crude oil, refuse and fuels of such type, however, a complete change in the programme is required, and it is with such fuels that engines of the Diesel type have made the most remarkable advances during the past few years. Engines of this type are adapted to use fuels of widely varying characteristics, covering practically the entire range of the heavier hydro-carbon oils and their distilled products and with a *thermal* economy unattained, perhaps, by any other form of heat prime mover. They are heavier than gasoline (petrol) engines per horsepower developed and require careful supervision and care. Their valuable characteristics have, however, gained recognition to such an extent that we find them in use in both the naval and commercial marines in all sizes, including an English battleship design of 36,000 aggregate horsepower on three shafts. Typical sizes are, however, between 100 and 1,000 horsepower, with 4 or 6 cylinders, and with single or twin shafts. There have recently appeared, however, several designs, some of which are in operation, in which the power is in excess of 1,000 horsepower. The fuel economy of engines of this type will range from .4 to .5 pound per horsepower hour at near full load and up to .6 to .7 at one-third to one-quarter loads.

In addition to the gasoline (petrol) and Diesel types of engine, the internal combustion principle has furnished another strong competitor for certain types of marine service in the gas engine, using fuel furnished by a gas producer of the suction type. Such producers operate on coal fuel, preferably of the anthracite form, and furnish a gas having a heating value from 150 to 250 B. T. U. per cubic foot. The fuel economy of such plants is about one pound of anthracite coal per horsepower hour. The low-heating value of the gas requires higher compression than with gasoline (petrol) vapor and other minor changes in the design of the engine. In general, the engine design follows the characteristics which have been worked out in connection with the use of gas of this character, and with only such structural variations as would serve to adapt it to the requirements of marine service. The total weight of gas producer and engine in such an installation is much greater than in the case of the gasoline (petrol) or fuel oil engine alone, and for this reason such form of power installation is only suitable in craft intended for moderate or slow speeds.

Within these limitations, for canal boats, lighters, small cargo carriers, etc., there is a fair field for the further trial of power equipment of this character.

In the general field of internal combustion engines, gasoline (petrol) must, by reason of its price, be restricted to pleasure and racing craft, while the field of commercial use is open to either oil engines or producer gas equipment. At the present time the oil engine seems to be decidedly in the lead. Further experience alone, however, can determine their relative merits for different demands of service and the particular types or conditions for which one or the other may prove to have superior adaptation.

In the entire field of marine engineering the most notable feature during the past fifteen years has undoubtedly been the phenomenal advance which the internal combustion motor has made, and the point of greatest present uncertainty is, perhaps, the result of the competitive struggle which we see now going on among the various forms of marine power equipment.

Propulsion

From the time of its introduction early in the nineteenth century the screw propeller had won and maintained a place of continuously increasing importance as a means of marine propulsion, and by the last years of the century the field was quite definitely divided between the propeller and the paddle-wheel. During the fifteen years since that time the situation remains much the same, with perhaps some small further restriction in the field of the paddle-wheel. For river service where large craft may be required for navigation in shallow water, and in general for all cases where moderate or large-size and shallow draft are combined, the paddle-wheel still finds a useful and effective field of service. For the entire field of deep water craft, and in general wherever the draft is sufficient to secure the immersion needed by the propeller, the latter is the accepted and normal means of propulsion. Even in the field of shallow water craft the propeller has made advances during the past fifteen years, and, by means of special forms at the stern so adapted as to insure proper immersion for the propeller, the latter has shown its practicability for river and other craft of relatively light draft.

The paddle-wheel either as side wheel or stern wheel has remained in design and construction practically unchanged during the period under consideration. Here again we have, so far as the design and construction of the wheel itself is concerned, practically a finished engineering product, and so long as paddle-wheels are used at all there is no reason to anticipate any marked change in their characteristics of design or construction.

Regarding the screw propeller, there has accumulated during the period under consideration an enormous amount of experimental model data resulting from investigations in Europe and in the United States in Government and private experimental tanks, as a result of which the design of the propeller is placed on a much more secure footing than in the closing years of the last century. The results of these investigations show that propellers under favorable conditions may develop efficiencies of 70 percent or slightly better. The main problem has been therefore to so correlate these results as to indicate clearly the possibilities in any proposed case, and the combination of characteristics which will insure the maximum efficiency, or as near to such value as may be practicable. There is perhaps no problem in engineering the solution of which depends in so intricate a manner on the many factors which are required to define a given case. As a result, the design of the propeller must be in chief measure empirical, and with uncertainty regarding the suitable values to be assigned to various factors the results on the average must of necessity fall far below the maximum actually attainable. The really important problem during recent years has therefore been, not so much the design or development of some special type of propeller of hitherto unattainable efficiency, as the accumulation, analysis and correlation of experimental results in such manner as to make possible the general raising of the great mass of average practice. This important service has in large measure been rendered by the work of the past fifteen years, and, while much yet remains to be done, especially in outlying portions of the field, nevertheless the designer who makes suitable use of these accumulated stores of data may be assured, for the approximately normal case, of a result not far from the maximum permitted by his limiting conditions.

A problem of peculiar importance in connection with the application of the turbine to marine service has been the investigation of the propeller of high revolutions and low-pitch ratio. Before the advent of the turbine the usual pitch ratio ranged from 1 to 1.6 or 1.8. With the high rotative speeds of the turbine, pitch ratios .40 to 1 became common, opening up a new and unexplored field to the designer of the propeller. Experience with full-sized propellers, as well as model experiments, all confirm the general conclusion that the use of pitch ratios much below 1 is attended with a distinct loss in efficiency as compared with the higher pitch ratios typical of practice with the reciprocating type of prime mover. By an increase in size and a narrowing of the blades the loss may be minimized, but under ordinary working conditions some loss in efficiency must be anticipated in connection with the high rotary speeds of the turbine, and in such fact we find one of the relative disadvantages of the turbine type of motive-power equipment. The use of some form of reduction gear between the turbine and propeller, as elsewhere noted, is, in effect, a recognition of this fact.

The present typical screw propeller may have either three or four blades, each blade being of a generally elliptical or oval contour, carefully formed and in the best design surfaced by grinding on both front and rear faces. The blades may be either cast solid with the hub or detachable. In all large propellers the latter form prevails. Cast iron, cast steel and bronze are used according to grade and character of practice. The latter is always preferable on account of strength, toughness, smooth surface and low frictional resistance, and is always employed in the best practice.

Investigation shows that the present propeller under the best conditions approaches very close to the limit of possible efficiency, and that there is therefore but little gain to be expected in the maximum possible results. The outlying field which still remains, consists rather in an extension of the results of the past fifteen years, and the broadening of our foundation for the sure and effective treatment of every problem of propeller design in such manner as to insure the realization of the maximum efficiency compatible with the selected limiting conditions of operation.

Auxiliaries

Only brief mention need be made of auxiliaries so far as propulsive machinery is concerned. The same general kinds of auxiliary machinery have remained in use throughout the period under consideration, with occasional improvements or developments in type or detail. Thus blowers, pumps, condensers, etc., have remained in broad outline much the same during the past fifteen or twenty years. In detail and in particular types many improvements have been made. Thus the narrow vane or sirocco type fan has come forward and is accepted as superior in efficiency and general effectiveness to the older type. The centrifugal pump has become generally accepted as the typical form of pump for circulating water through the condenser. The functions of the air pump, especially for turbine service, have been subdivided, and the water of condensation, or condensate, is drawn out by a small centrifugal pump and passed along to the hot well, while the air is withdrawn by specially designed forms of so-called dry vacuum pumps. Of these there are three types at the service of the designer, the old and familiar piston type with specially improved details of valve movement and function, the rotary, represented by such pumps as the Rotrex, and more recently the Le Blanc type. Electric motor drive for auxiliaries such as centrifugal pumps and fans has become common, and in these general respects the practice in the marine engine and fire-room has kept well abreast of the many improvements in general engineering practice regarding such items of equipment as may serve a collateral or auxiliary service in

connection with the operation of the main propelling machinery.

Materials

One of the most significant features in connection with general engineering progress is the extent to which developments and improvements in one field are conditioned or made possible by progress in another. Nowhere is this more clearly shown than in the part which improved or new structural materials have played in making possible improvements in the field of marine design, especially in the line of increased power per pound of machinery or per ton of displacement, and in consequence higher speed or increased carrying capacity. The modern boiler, high-speed steam engine, turbine or internal combustion motor, line and propeller shafting and propeller itself, all depend in their present typical form and design on the possibilities which have been placed in the hands of designers of marine machinery by improvements in the constructive materials of engineering.

Special alloy steels such as nickel, vanadium, chrome, tungsten, etc., furnish, as may be desired, materials with the maximum combination of tensile, shear or compressive strength, toughness, hardness, resistance to high temperatures, or abrasion, and with any one combination of related qualities magnified to any degree within limits.

Again, special bronzes for propellers and bearing shells and a long line of special bearing metals have also contributed their quota in the developments during the past fifteen years. Limitations of space preclude any detailed examination of this subject, but in passing in review the various advances in the field of marine design and operation we must not forget that with regard to structural materials this period has contributed, perhaps beyond that of any other equal period, to the extension of the resources placed at the immediate disposal of the designer of marine machinery.

Size and Power

Continuous and definite though by no means startling advances in size and power of propelling machinery and in speed of ship have characterized the developments of the past fifteen years in the marine field.

In the early years of this period 10,000 horsepower per shaft with reciprocating engines was well within the limits of achievement. At the present time perhaps twice this amount or 20,000 horsepower per shaft may be considered as equally within the limits of practical realization. These larger amounts of power are for the most part with turbine installations. In this respect, regarding the size of the unit itself, and in particular since the diameter of the shaft depends on rotative speed and power, the turbine has a distinct advantage over the reciprocating engine, although, as previously noted, the application of the power through the propeller at high rotative speeds is less efficient than at low speeds. So far, however, as size and power of units per shaft are concerned, the progress has simply kept pace with the demand, and, within a limit which it would perhaps be difficult to set at the present time, there seems to be no reason why the size and power of such units should not continue to increase in answer to further demands along the same line. In addition, however, to an increase of power per shaft, the problem of increased total power has been further met by an increase in the number of shafts. This again is made the more possible with turbine installations by reason of the high rotative speeds and relatively smaller propellers.

The total power of propelling machinery has likewise grown in answer to the growth in two measurably distinct characteristics of ship design and operation; increasing speed by itself, and increasing size of ship. Either singly or both in combination demand increasing total propulsive powers. In the early years of the period under consideration, the maximum total propulsive power in large mercantile steamers was represented by amounts from 20,000 to 30,000 horsepower, for ships of 25,000 to 30,000 tons displacement and for speeds of about 22 knots. For warships of the battleship type the maximum power was represented by some 15,000 to 18,000 horsepower for ships of about 15,000 tons displacement, and at speeds of 18 or 19 knots.

At the present time the maximum in mercantile marine is represented by a total powers from 50,000 to 70,000 horsepower for ships of 40,000 to 60,000 tons displacement and for speeds 24 or 25 knots; while for warships the superdreadnoughts and battle cruisers require aggregate powers of 30,000 to 50,000 horsepower for displacements of 25,000 to 28,000 tons and speeds of 22 to 25 knots.

Economy

The advance in economy of propulsion by way of steam prime movers has been comparatively small during the period which we are considering. The reciprocating steam engine has only improved in minor degree. Superheated steam and higher steam pressures have advanced only moderately, and the gain which has been made in engine economy is small compared with the great changes which have been noted in other directions. Steam turbines operated at or near their most economical point, that is, at or near the single speed for which they are designed, have shown an economy on the whole better than reciprocating engines, though in the same general class, while, if used over a wide range of speed, the economy as noted elsewhere is distinctly inferior to that of the reciprocating engine. From 12 to 15 pounds of steam per shaft horsepower hour independent of auxiliaries will represent in the main results which good practice may now hope to attain. In special cases with superheated steam and particular attention to economy, the figures have been reduced close to 10 pounds. Auxiliaries included, these figures will be raised by 10 to 20 percent. These figures represent something from 1.1 to 1.5 pounds of coal per shaft horsepower hour for all purposes as typical of good present practice, figures which had been achieved in detached cases during the closing years of the last century. In smaller craft the situation is similar. Here the fuel consumption has remained without essential change from 1.5 pounds to three and four pounds, depending on conditions of operation.

The most significant outlook for improved economy seems to lie in connection with the internal combustion engine and in particular for small and moderate sizes. The economy of such forms of motor has already been noted, and when reduced to financial basis it readily appears that the crude oil motor and producer gas installations are the only types which seem to give definite assurance of reduced propulsive cost as compared with steam. If Diesel type motors can insure continued operation on .4 to .6 pound of oil per shaft horsepower hour, then, with a not improbable relative cost between coal and oil, the latter will be able to show a marked saving as compared with coal, and this on fuel cost alone. If in addition allowance be made for saving in personnel and general fire-room expense, the gain will be still more significant.

With producer gas installations giving a shaft horsepower hour for about one pound coal, the saving will be relatively small in large high-grade practice, but more in small craft, where high efficiency is more difficult to obtain with steam prime movers than with internal combustion engines.

On the whole, we must accord to the internal combustion motor, and in particular to the Diesel type, credit for the most significant progress during the past fifteen years and for the most hopeful promises for the future regarding the important features of economy in the development of power for marine propulsion.

Possibilities of Montauk Point Relative to the Atlantic Express Passenger and Mail Service

BY WILLIAM T. DONNELLY*

This is a subject which has been under discussion for a great many years, and one which has been brought to my attention on numerous occasions, and until very recently I have been very pronounced in my attitude as to the unreasonableness of any such undertaking, but the persistency with which this matter has been agitated has led me to give it considerable study, and this has developed an entirely different point of view, which, while it may not be conclusive, seems to be sufficiently sound to warrant some consideration.

The general discussion of this subject has always tended toward the possibility of a freight line and cheap shipping facilities, and from this point of view I can see no possibility of a development, as the approach would be limited to the tracks of the Pennsylvania Railroad. My new point of view is the possibility of an express, passenger and mail service. It is apparent that, due to the shorter distance and the ease of entering the port at Fort Pond Bay, Montauk Point, Long Island, the *Mauretania* and the *Lusitania* could shorten their trips by about seven hours. This does not seem much on the face of it, but it would mean fourteen days a year or two more trips for each vessel in the year, and this without the expenditure of any additional coal and without any additional expenditure for officers and crew. Reduced to its lowest term, this means, with the same investment of capital, the same maintenance and expense accounts, the adding of an enormous sum to the earning capacity, not simply the 4 percent represented by two additional trips in fifty, but a very much greater amount, due to the fact that nearly the total receipts of these two trips would be added to the profits.

If this terminal can be brought about, mainly at the expense of the United States Government and the Pennsylvania Railroad, it would seem to be a very handsome thing for the steamship company, and, considered from the railroad point of view, it would seem to have attraction enough for the Pennsylvania Railroad to make them interested, as they would have the only direct through-rail connection to the fastest passenger and mail line across the Atlantic.

Of course, we have to consider the alternative, such as saving by sailing from Boston, Mass., and other far Eastern ports, but I would point out that it will be practically impossible to take away from New York the distinction and prestige of the most direct and highest class connection with Europe, and, as regards Boston and New York, Montauk Point would be a neutral point and would put Boston in almost as good position relative to the point of departure as New York City.

Granting the project as outlined as a possibility, the relative position of the Canadian Grand Trunk System to such a development is a point of interest. The distance from New London, Conn., to Montreal, Canada, is 376 miles and the distance from Montauk Point to New London 20 miles by water. To make this comparable to railroad miles, I have multiplied it by 3, or called it 60 miles. This would make the distance from Montauk Point to Montreal 436 miles. The distance from Montauk Point to New York City is 118 miles and from New York to Montreal 399 miles, or a distance of 517 miles, which gives 81 miles relative advantage by the Central Vermont Railroad from Montauk Point to Montreal.

The question then is, whether this would be sufficient to give the Grand Trunk Pacific Railway the control of the fastest mail and passenger route from Montreal, Canada, and the Northwest, as against any other possible connection. If this would work out, it would appear to offer some additional inducement for the adoption of Montauk Point as a point of departure for the transatlantic express passenger and mail service.

Of course, the question will be raised as to New London as a point of departure; but I think this will be impossible, as in any rail contest the Pennsylvania Railroad would always dominate the New York, New Haven & Hartford Railroad, and, besides that, the concession of such a terminal to Connecticut by the great State of New York is practically out of the question. It is quite possible, however, that if the express passenger and mail service should leave Montauk Point, the general agitation of the subject might develop a secondary line of freight and passenger service from New London to Europe, as New London has one of the best and most accessible harbors on the coast; and, of course, this would be of great advantage to New England.

In any discussion of this subject, our friends in Canada will insist upon the consideration of one of their Eastern ports, such as Halifax, Nova Scotia, which is free from ice the year round.

I make the railroad distance from Halifax to Montreal 836 miles and the distance from Montauk Point to Montreal, as previously stated, 436 miles, a difference of 400 miles in favor of Montauk Point. For a matter of comparison, I will turn this distance into time by using 50 miles per hour as the common mail transportation speed. This gives Montauk Point eight hours' preference over Halifax in relative rail distance.

I find that the fastest steamers from Halifax are the *Virginian* and the *Victorian*, making 18 knots. To make the comparison more simple, I will turn the eight hours' time into added distance between the Port of Halifax and Liverpool. Eight hours at 18 knots would mean 144 knots. This, added to the distance from Halifax to Liverpool, 2,485 miles, would make 2,629 miles, and this distance, at 18 knots, would require 146 hours.

The distance from New York to Plymouth is 2,973 miles. Allowing 125 miles between New York and Montauk Point, would make a sailing distance of 2,828 miles. The speed of the *Mauretania* and *Lusitania* is 25½ knots. This would make the sailing time 111.6 hours, or a saving over the Montauk route, as compared with the Halifax route, of 34.4 hours.

It is, of course, apparent that this advantage of Montauk Point is due to the difference in speed of the boats, which brings the question down to the consideration as to whether this difference will be continued. In this connection, the first point to be decided is the speed of the boats that would be required to put Halifax on an equal footing with Montauk Point. This is readily obtained by dividing the Halifax mileage by the time consumed in traveling the Montauk course. This gives the required speed as 23.5 knots. While it is, of course, entirely within the bounds of possibility that boats of such a speed may be run from Halifax, I do not consider it at all practicable. To obtain this speed with any degree of regularity, the boats would have to be of tremendous power and very large size, and to return anything upon the investment they must receive a tremendous subsidy, as they could not receive anything like the patronage assured to a line directly connecting such a city as New York.

It may be of interest to consider briefly the actual financial sums involved in such a transatlantic line as is referred to. The cost of the *Mauretania* and *Lusitania* was approximately $6,500,000 (£1,337,000) each. The capital for these vessels was loaned by the British Government at a rate of interest approximating 2¾ percent. It is a very reasonable supposition that this line is operated for a net return of this amount plus 5 percent, or a total net revenue of 7¾ percent

* Consulting Engineer, 17 Battery Place, New York.

per annum. This would mean a net revenue of $503,750 (£103,700) per year, or, figuring on a basis of fifty trips, would mean approximately $10,000 (£2,055) per trip.

It would be entirely within the bounds of business experience to estimate the net receipts from a trip as not more than 20 percent of the gross receipts. On this basis, the returns from two additional trips would be an additional $100,000 (£20,550) per year, an amount equal to 20 percent of the present total net revenue.

The foregoing is not intended to be an accurate presentation of the facts, but is believed to be substantially correct, and is intended to be an illustration of the economic principles involved in the greatest possible utilization of revenue-earning power of transportation means.

New Tank Steamer for the Gulf Refining Company

The Gulf Refining Company, of Pittsburg, Pa., has under construction a new tank steamer which will have a greater bulk of oil-carrying capacity than any other tank vessel operating under the American flag with the exception of the *Oklahoma,* which is owned by the same company.

Contract for the new tank steamer, which is to be named the *Gulfoil,* was placed with the New York Shipbuilding Company, Camden, N. J., and the vessel is being built from designs prepared by Mr. George B. Drake, New York, the naval architect, who also designed the *Oklahoma* and other craft for the same owners.

The *Gulfoil is* being built to the highest class in Lloyds and under Lloyds special survey. The dimensions of the ship are as follows:

Length over all	406 feet 6 inches
Length between perpendiculars (Lloyds)	392 feet
Beam, molded	51 feet
Depth, molded to upper deck	30 feet 2 inches
Depth to main deck	22 feet 8 inches
Deadweight carrying capacity on 23 feet 6 inches draft	7,257 tons

The steamer is of the two-deck type with raised forecastle bridge and poop decks with a continuous expansion trunk between decks and a raised expansion trunk above the upper deck over the five after tanks. The expansion trunk sides, both between decks and above the upper deck, are continued by the machinery casing, thus greatly increasing the strength of the ship. The full poop will add greatly to the dryness of the ship and to the comfort of the crew. The main scantlings for the construction of the hull are shown on the midship section, and the arrangement of the transverses, longitudinals, bulkheads and decks is shown on the general plans.

Instead of following the usual method of construction, the owners decided to adopt the Isherwood System, consisting of longitudinal instead of transverse framing, a system now being used extensively in Europe, although this is the first tanker of this type to be contracted for in the United States. The results will no doubt receive considerable attention, particularly in view of the fact that, in addition to the practical advantage attained, a very material saving in weight of structural material has been effected, together with an increase of longitudinal strength as compared with the ordinary construction, resulting in an appreciable saving in the first cost of the vessel, as well as securing an additional carrying capacity of about 230 tons beyond what would be obtained in a ship of similar dimensions built under the old method.

When fully loaded the vessel will carry 2,285,000 gallons of oil in bulk, contained in twenty-two separate oil-tight compartments, in addition to which there are also a large cargo hold, and smaller compartments, furnished with all the necessary cargo booms, winches and handling gear, in which barreled oil or general cargo can be transported.

The steering engine will be a Brown steam tiller fitted direct on the rudder stock and worked from the bridge, as well as from aft, by the latest type of telemotor gear, while for additional safety there is also an independent hand gear, which can be used to steer the ship when occasion requires.

On the stern of the ship there will be placed a powerful automatic machine, furnished with a heavy steel hawser, for towing purposes; the anticipation being that this steamer, like others of the fleet, will have a barge as a consort, and for that reason a considerable margin has been allowed in the proportions of the machinery so that there may be no appreciable delay to the steamer, even in the event of her having a barge in tow.

The ship's officers and operator for the wireless system, with which the vessel will be equipped, are provided with adequate and comfortable quarters amidships, in a house raised above the bridge deck and communicating with the after part of the vessel, where the dining saloon is located, by means of a substantial fore-and-aft bridge. The engineers, petty officers and all other members of the crew, are suitably housed under the raised poop deck, aft. The galley, saloon and petty officers' mess are located in a steel house in the poop deck and the crew's mess rooms, steward's storerooms and other essential accommodations are located under the poop deck, thereby minimizing and confining the work of the steward's department within as small an area as possible.

As on all the vessels operated by this company, oil will be used as fuel and will be carried in bunkers having a capacity of 176,000 gallons, so arranged at both ends of the vessel that either cargo or fuel can be carried therein; which arrangement also permits of considerable latitude in trimming the boat to suit the different conditions of loading.

The cargo-pumping arrangement, due to the many different grades of oil likely to be carried in the numerous compartments, is of necessity somewhat elaborate. Considerable attention has been given to this feature, in connection with the excellent loading facilities provided at the company's new docks at Port Arthur, resulting in a simple and efficient arrangement of pumps and piping. In all there will be seven pumps of the Warren Steam Pump Company make. Six of these are 10 inches by 8½ inches by 12 inches duplex, and the other 12 inches by 10 inches by 12 inches duplex. Each pump is capable of discharging cargo at the same time, through an independent line. In the pump room, which is at the after end of the cargo tanks, there will also be installed an air compressor, which can be used for testing lines, operating pneumatic tools and various other purposes for which compressed air can be utilized.

Machinery

Following the usual custom the propelling machinery is placed aft. The main engine is of the vertical, inverted, triple-expansion type, surface condensing, with three cranks at angles of 120 degrees. The cylinders are 27 inches, 45 inches and 75 inches diameter, with a common stroke of 48 inches. The high-pressure cylinder is forward and the low-pressure aft. The high-pressure and intermediate-pressure valves are of the

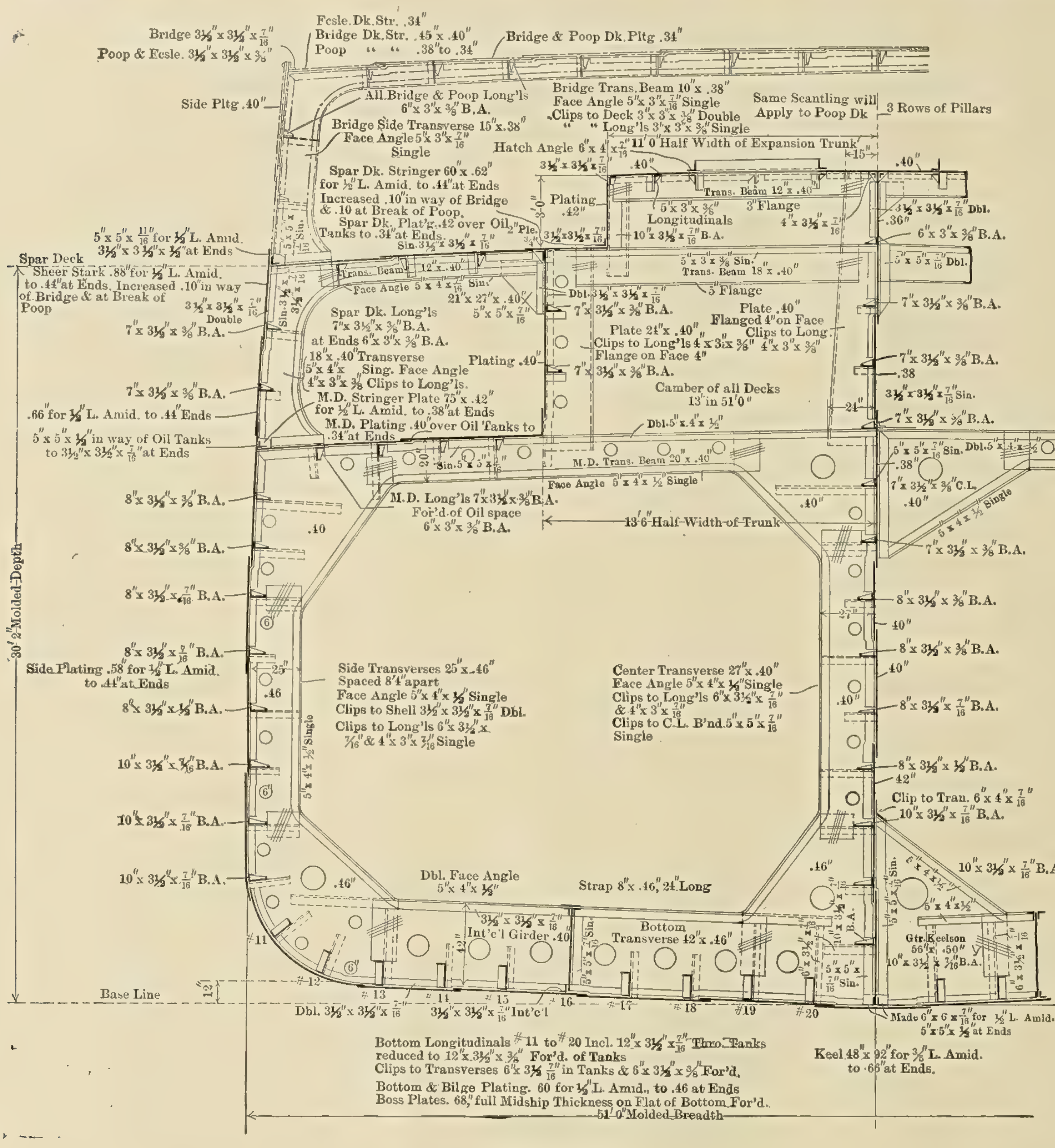
piston type and the low-pressure valve a balanced slide valve. All of the valves are operated by the Stephenson link reversible gear. The intermediate and low-pressure valves are to be equipped with Lovekin assistant cylinders. The engines, when working at their maximum power, will develop 2,700 indicated horsepower, which will give the vessel an average sea speed of 11½ knots.

The main condenser, which is independent of the main engine, is of the cylindrical type, containing 4,800 square feet of cooling surface, designed to maintain a vacuum of 26½ inches, with circulating water at 86 degrees Fahrenheit.

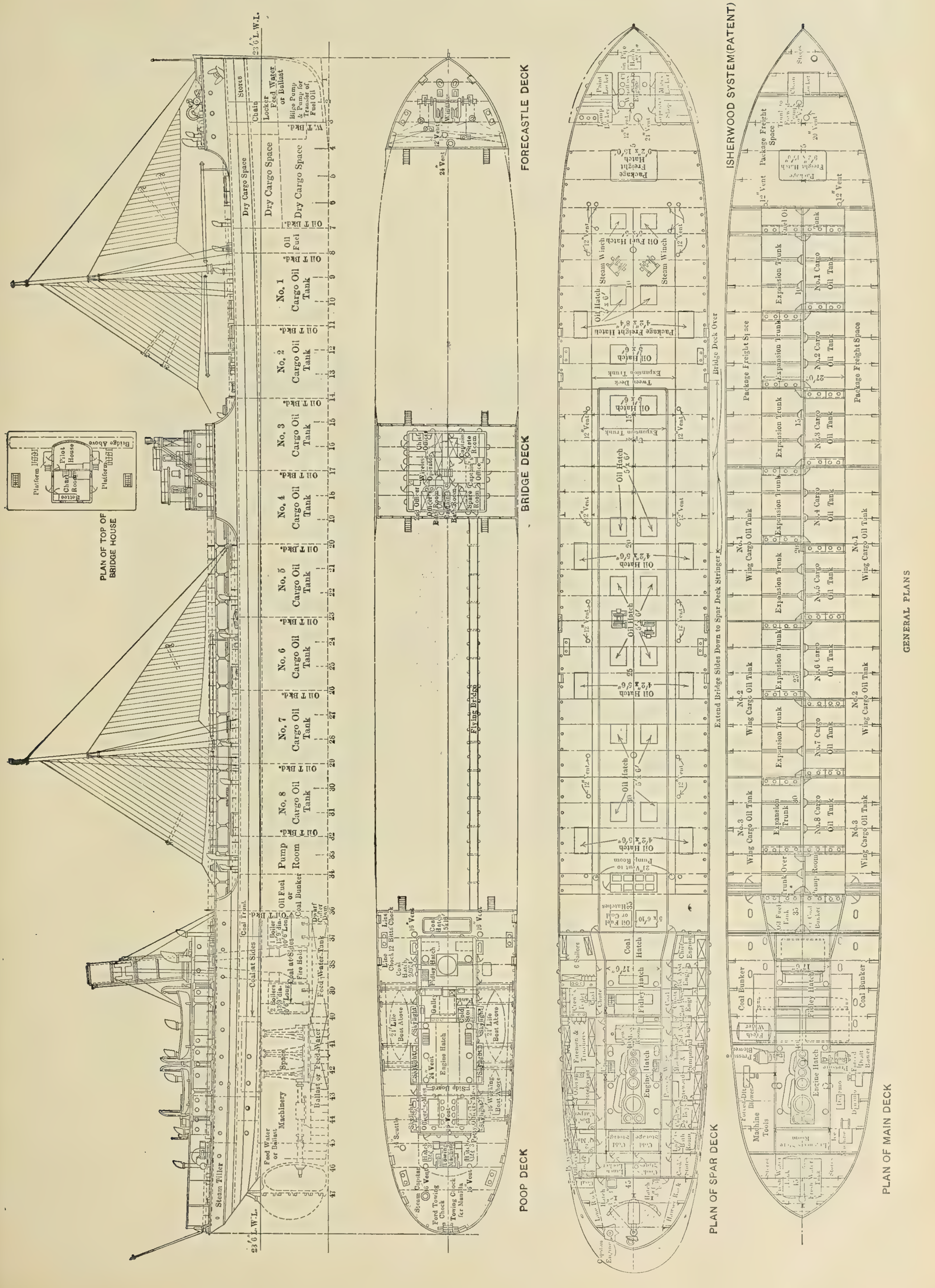
The reversing gear is of the ram type secured to the main engine, and there is a steam-turning gear with a single cylinder reversing engine operating a shaft and a worm engaging a worm wheel on the main crank-shaft. The thrust bearing is of the horseshoe type fitted with ten collars. One main air pump, two bilge pumps and one sanitary pump are driven direct from the low-pressure crosshead. These are single-acting, arranged vertically.

The main feed pump is a vertical, single, long-stroke pump of the Weir type, 12 inches by 8½ inches by 16 inches. An auxiliary feed pump of the same size will also be fitted. There is one donkey pump of the horizontal duplex piston type, 12 inches by 10 inches by 12 inches. Also two pumps, one for water service and sanitary purposes and the other for fresh water of the horizontal duplex piston type, 5 inches by 4¾ inches by 6 inches. The circulating pump is of the centrifugal type, operated by a single vertical engine. An auxiliary condenser of 900 square feet cooling surface is furnished with air and circulating pumps to provide for all the pumps and auxiliaries. A Griscom-Spencer evaporator of 25 tons' capacity in twenty-four hours and a Griscom-Spencer feed water heater of 225 square feet heating surface are installed.

In addition to the usual auxiliaries required in the engine room, the vessel will be furnished with a two-ton ice machine, connected with ample cold-storage capacity, thereby enabling the vessel always to be well supplied with an abundance of fresh stores. There will also be fitted in the engine



MIDSHIP SECTION



GENERAL PLANS

room an up-to-date machine shop, supplied with an electrically driven lathe, shaper and drill press and a complete outfit of tools necessary for effecting such ordinary upkeep and repairs as have to be dealt with.

Steam is furnished at a pressure of 190 pounds per square inch by three single-ended Scotch boilers, which have an inside diameter of 14 feet 8 inches, and the length between heads is 11 feet. Each boiler has three Morison corrugated furnaces, 42 inches inside diameter. The tubes are of seamless cold drawn steel, 2½ inches diameter. The boilers are fitted so that either oil or coal can be used for fuel, but they are primarily equipped for oil burning. Each boiler is equipped with a water purifier, oil separator, heater and circulator located in the top of the boilers and connected up to the main and auxiliary feed lines provided with blow-off pipes. A forced draft system of the hot-air type is installed, two blowers being located in the engine room and direct-driven by vertical engines. The blowers will be of size to maintain an air pressure in the ash pit equal to a column of water 2 inches in height.

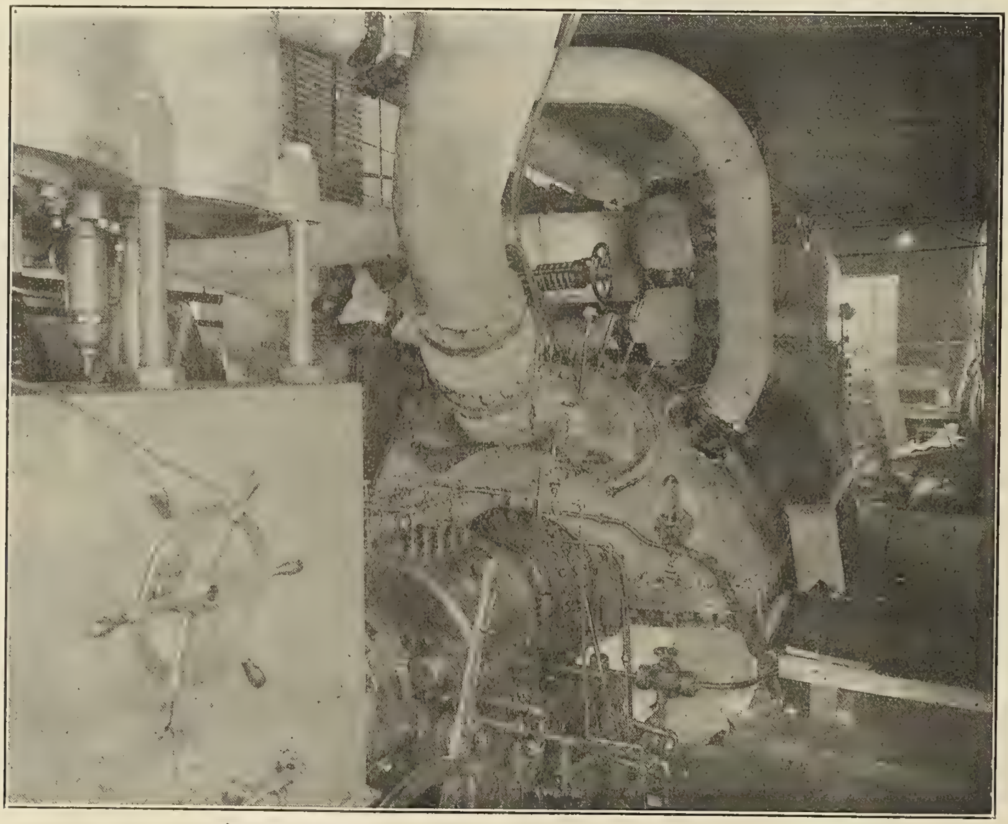
The oil fuel system is designed so that a mechanical atomizing system can be used. Each furnace will be equipped with one burner. Two duplex oil fuel pumps, 5¼ inches by 3½ inches by 5 inches, are connected to steam and exhaust lines and two oil heaters are located in the boiler room. The pump is arranged to draw from the oil fuel tank manifolds and discharge through an equalizing tank and the oil heaters, or direct, into a distributing system on the boiler fronts.

The electric plant consists of two 10 kilowatt General Electric marine direct connected sets for 110 volts, driven by vertical engines located on the main deck in the engine space.

In conclusion, it might be said of this vessel that a large cargo is being carried on limited proportions, without sacrificing either speed or durability, while every attention has been given to economy in working and facilities for operation, and that, with this valuable addition, the carrying capacity of the company's fleet is increased by about forty million gallons per annum, so providing equipment of the most modern type to meet the requirements of a rapidly growing business.

Tests of a Combination Reciprocating Engine and Curtis Turbine Unit

The Fore River Shipbuilding Company, of Quincy, Mass., has recently completed a series of tests of the machinery for one shaft of one of the later United States destroyers. This machinery was designed primarily to secure the maximum economy at low speeds of the vessel while maintaining the advantage of the turbine installation at the higher speeds, and consists of a 63-inch, 18-stage Curtis marine turbine, to the forward end of which a compound reciprocating engine is attached, by means of a clutch, which permits of this engine being connected or disconnected at will.



VIEW OF COMBINATION MACHINERY IN FORE RIVER SHOPS, SHOWING THE TURBINE

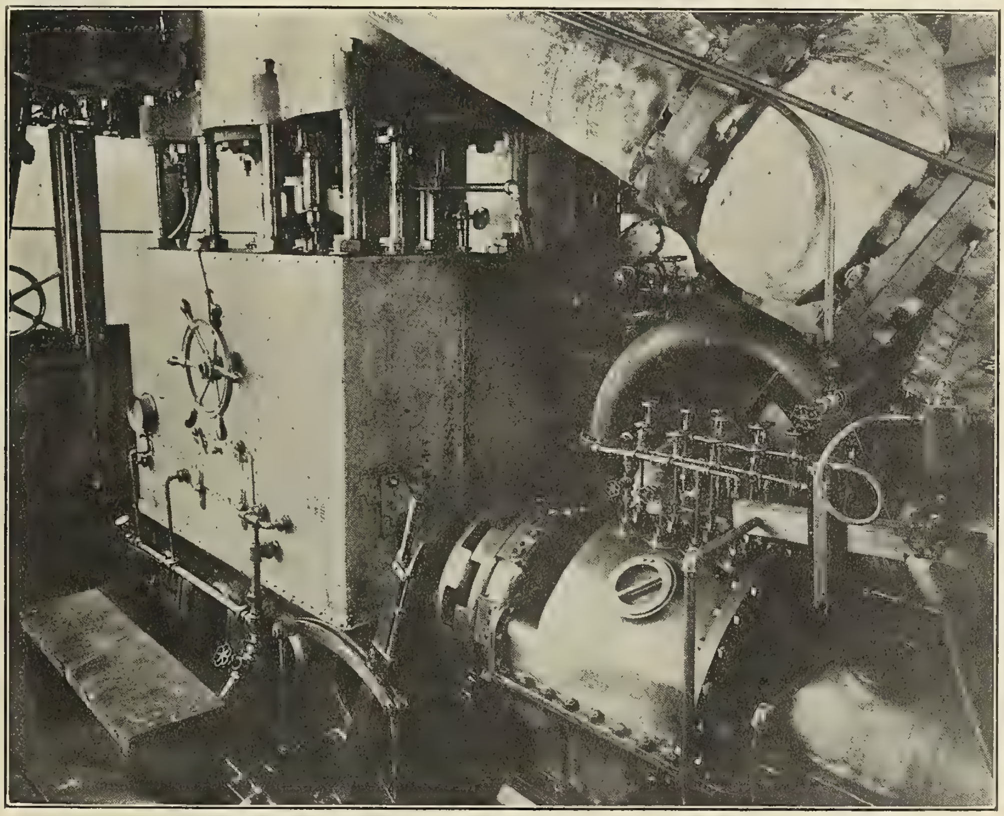
As set up for test, the installation consists of the above mentioned turbine and reciprocating engine, together with its condenser, circulating pump and air pump and one length of line shafting carrying two torsion meters of different makes for the measurement of the power. To the end of this shaft is connected a Froude absorption dynamometer with a brake arm carrying known weights so that the power absorbed can be accurately determined. This also serves as a check on the torsion meters.

The steam for the test was furnished by two watertube boilers which are a part of the regular equipment of the yard. The steam for the auxiliaries was taken from the same line, but they were allowed to exhaust into the open air, so that only the steam used in the main engines went through the

UNITED STATES DESTROYER *HENLEY*. SHOP TEST OF STARBOARD UNIT. SUMMARY OF TESTS—DECEMBER 27-28, 1911.

Test No.	Duration of Test. hrs. min.	Main Steam: Pressure Lbs. Absolute.	Main Steam: Degrees Superheat.	Steam at Turbine Chest: Lbs. Absolute.	Steam at Turbine Chest: Degrees Superheat.	Turbine Exhaust. Lbs. Absolute.	R. P. M	B. H. P.	W. R. Lbs. per B. H. P.: Actual.	W. R. Lbs. per B. H. P.: Cor. To 28.5" Vacuum.	Percent Improvement of Combination over Turbine: Actual.	Corrected to 28.5" Vacuum.	Corrected to Same Vacuum and Steam Cond.	
4	1 ..	261.8	32.5	146.7	16.	.835	176.2	161.	39.7	39.	.....	.....	.....	Turbine 10 knots
5	1 18	262.3	0.	147.3	10.	.923	174.3	159.4	20.6	19.7	48.1	48.8	49.9	Combination
2	1 ..	259.0	49.	230.8	16.	.953	235.	352.5	28.2	27.2	.....	.....	.....	Turbine 13 knots
1	1 48	259.0	0.	216.5	5.4	.825	231.	347.	17.4	17.1	38.3	37.2	39.9	Combination
3	1 ..	256.5	62.5	220.	30.	1.01	290.4	622.	22.3	21.3	.....	.....	.....	Turbine 16 knots
6	1 30	260.1	59.	253.5	46.	.933	284.	608.	16.5	16.0	26.0	24.7	24.8	Combination
7	.. 30	260.3	75.	249.8	65.5	.928	284.	487.	14.6	14.0	34.6	34.2	.....	Compound Special

Test No. 6 had some live steam admitted to the turbine.
Test No. 7 had all steam passing through the reciprocating engine and is the true measure of the gain obtained at 16 knots.



VIEW OF COMBINATION MACHINERY IN FORE RIVER SHOPS, SHOWING RECIPROCATING ENGINE AND CLUTCH

condenser, from which it was taken by the air pump and delivered alternately to two tanks placed on scales, by means of which it was accurately weighed. The plant was equipped with all the necessary instruments for determining the pressure and quality of the steam admitted, the vacuum, revolutions per minute and other data required.

A series of tests was made, first, to determine the steam required per brake horsepower for the turbine alone when run at the power and revolutions per minute necessary to propel the ship at speeds of 10, 13 and 16 knots. Second, these were duplicated in respect to power and revolutions per minute, with the reciprocating engine in gear and exhausting into the first stage of the turbine. The results obtained are given in the accompanying table. These show a marked gain in economy obtained by the use of a reciprocating engine in combination with a turbine over the turbine alone, being 48.1 percent at the 10-knot condition, 38.3 percent at the 13-knot and 34.6 percent at the 16-knot condition.

The Eighth Annual New York Motor Boat Show, which was held at the Madison Square Garden Feb. 17th to the 24th, gave some indications of the rapid strides which the motor boat business has made in recent years. The numerous exhibits of both boats and motors and accessories showed that steady progress has been made in perfecting the various details which go to make up a successful boat of this type. Speed, of course, has played an important part in certain types of boats, and phenomenal results have been obtained with small-sized hydroplanes. The general tendency in the cruising type of boats has been towards more comfortable accommodations and greater conveniences for living on board than have been available previously. No radical improvements have been made in the development of engines, although the details in general have been bettered, and the engines have become a more reliable and useful machine for all classes of work. The appearance of a Diesel engine exhibit in this year's show is a new departure which offers much promise for the future.

New Orient Mail Steamer Orama For Australian Service

The new Orient liner *Orama* was built at Clydebank for the Orient Steam Navigation Company's new Australian service. She is a triple-screw steamer with a combination of reciprocating engines and turbines, and she completes the list of six vessels necessary to enable the Orient Company to carry out the terms of their mail contract with the Australian Government. This contract extends over twelve years and expires in 1920, and secures for the Orient Company an annual subsidy of $830,000 (£170,000).

The leading particulars of the *Orama* are as follows:

Length over all	569 feet.
Length between perpendiculars	550 feet.
Breadth, extreme	64 feet.
Depth to shelter deck	46 feet.
Draft	24 feet 6 inches.
Displacement	15,750 tons.
Speed at sea	18 knots.
Horsepower	12,000
Gross tonnage	13,000

The two sets of reciprocating engines are of the four-cylinder, triple-expansion, direct-acting inverted type, balanced on the Yarrow, Schlick-Tweedy system, and are arranged to take steam at 215 pounds per square inch. The cylinders are 27½, 42, 47 and 47 inches diameter, with a stroke of 54 inches in all cases. The valves admitting steam to the high-pressure and intermediate cylinders are of the piston type, while those for the low-pressure cylinders are of the flat type. The valve gear is of the usual link motion arrangement.

The low-pressure turbine, which is of the Parsons design, takes steam from the reciprocating engines. The rotor is built up of steel forgings, and the blading is of Parsons laced type, with brass distance pieces between the blades at their roots, and the lacing soldered on the edges. The turbine casing is of cast iron. The turbine is placed aft of the reciprocating engines, and is 11 feet diameter, designed to transmit one-third of the power.

The speed trials proved the arrangement of the machinery to be very economical. It was found that when burning a slightly less quantity of fuel per unit of grate surface, nine single-ended boilers sufficed where ten of the same size were required in the five earlier vessels, which had twin screws only. The speed trials were performed on the Clyde, and consisted of progressive runs on the measured mile, and continuous runs between the Cloch and Cumbrae Lights at 18½ knots, all of which proved highly satisfactory.

The *Orama* is built to the rules of Lloyd's register for the highest classification of that society. She is of the shelter deck class and has four tiers of beams below the shelter deck. There are ten watertight bulkheads sub-dividing the hull, and a cellular double bottom extends from fore and aft peak bulkheads. The double bottom carries 1,000 tons of water ballast, 500 tons of fresh water for ship's use, and 300 tons of fresh water for boiler feed reserve. The hull plating is of a uniform thickness of 15/20 inch, this thickness having been specially considered in relation to the frame spacing, which is 30 inches. The after framing is out-bossed around the side shafts, and the center shaft is carried in an ordinary stern frame having a small aperture. The rudder is of the straight type, having a single plate, and the stock is 12½ inches diameter.

The *Orama* is one of the most up-to-date liners on the Australian route. Her principal rooms are on the promenade deck. Forward is the first class lounge and music room, a spacious apartment decorated in Louis XVI. style, and aft are the first class smoke room, which is in Dutch colonial style, and the veranda café. The first cabin dining saloon is on the upper deck, and has separate tables for small parties. This room is decorated in Louis XVI. style, and the walls are in white and grey. The second and third cabin public rooms are correspondingly commodious and handsomely appointed throughout. There is accommodation for 293 first class passengers, 145 second class and 867 third class, all of it having been specially designed and fitted in order to meet the special conditions of the Australian trade.

The cargo is carried in six holds, four forward and two aft. A large portion of the forward holds is insulated for carrying perishable cargo. The refrigerating machinery consists of two of Haslam's compound dry air machines of a capacity of 85,000 cubic feet, with a CO_2 machine of a refrigerative capacity of 15 tons.

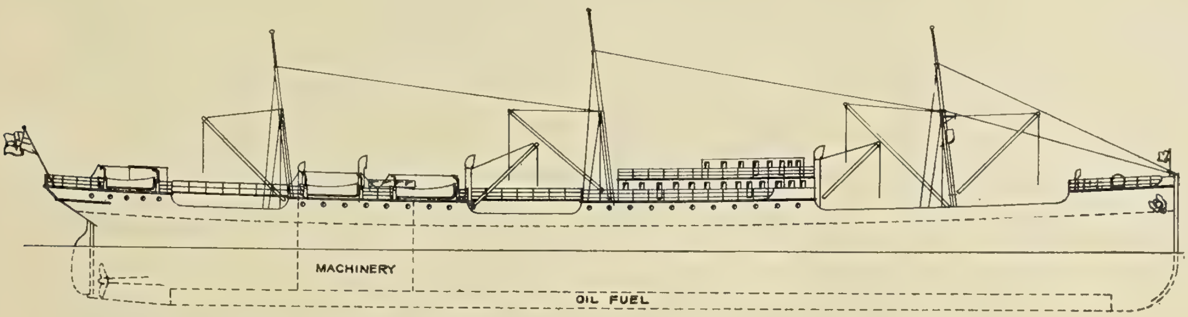
There is an auxiliary or alternative steering gear of the

NEW ORIENT LINER ORAMA, 13,000 TONS, 14,000 HORSEPOWER

electro-hydraulic type associated with the names of Dr. Hele-Shaw and Mr. Martineau, which was described and illustrated at the spring meetings of the Institute of Naval Architects this year. The makers of both the ordinary steam gear and that of the new type, the two, however, having a working association, are Messrs. John Hastie & Company, Kilblain Engine Works, Greenock, and from tests with the gears made while the vessel was undergoing speed and other trials on the Clyde, and while on her voyage to the Thames, it is understood that the power required to steer her on a course was found to be only a little over 2 horsepower. This, it can readily be understood, represents an enormous saving in a vessel of the size of the *Orama*. The absence of lost motion between the steering wheel on the bridge and the rudder was exceedingly marked, and it was found that a very much smaller amount of motion of the steering wheel was required to steer the vessel.

for only twenty first class passengers—one-berth cabins of exceptional size, with toilet and bath for every two cabins—and an extra feature is the servants' rooms, arranged in connection with the private cabins. There is a commodious lounge, a handsome smoking room and a dining saloon in white "Louis-seize" style, with a height of 12 feet to the ceiling. This accommodation is arranged in the No. 1 "island," and here are also the rooms for the captain, the chart house and the navigating bridge. The officers are berthed in the No. 2 "island" around the engine room casing. Besides the usual mess-room there is also arranged a roomy smoking saloon for the officers' use. The crew is accommodated in the poop.

The accompanying sketch shows a general view of the ship and gives an idea of the small space occupied by the machinery. As a matter of fact the machine room and casing had to be made bigger than strictly necessary in order to get the usual reduction in the tonnage.



DANISH MOTOR SHIP SELANDIA, 6,800 TONS DEADWEIGHT CARRYING CAPACITY, 2,500 HORSEPOWER

The Diesel Motor Ship Selandia

BY AXEL HOLM

A prominent Danish trading firm—the East Asiatic Company, Ltd.—is at present building three sister ships, two in Denmark and one in Scotland, for their Oriental service, which are to be fitted with Diesel motors. The following is a brief description of the first Danish-built ship, the *Selandia*, now nearing completion in the yards of the firm of Burmeister & Wain, shipbuilders and engineers, of Copenhagen. She was launched on Nov. 4, 1911, and will be turned over to the owners late in February. The *Selandia* is built for the route between Scandinavia, Genoa, Italy, and Bangkok, Siam. She is a twin-screw ship with a continuous main deck of steel, a forecastle, two "islands" and a poop deck and with three schooner-rigged masts. The main dimensions are: Length between perpendiculars, 370 feet; breadth, molded, 53 feet, and a deadweight capacity of 6,800 tons on a mean draft of 22 feet 6 inches. As there is only 13 feet over the bar at the port of Bangkok, Siam, she will be able to carry only 2,700 tons to the harbor in her holds, the remainder being transshipped into barges. The crude oil for the fuel is carried in the cellular double bottom.

The twin screws are driven each by an eight-cylinder, four-cycle Diesel engine of 1,250 horsepower. The engines are of the enclosed type, having both crosshead and piston rod. The reversing is done by moving the reversing shaft on the engines lengthwise by means of a single lever working on the air-driven starting engine. This arrangement has been patented by the firm.

The auxiliary machinery consists of two Diesel motors of 200 effective horsepower each, direct coupled to dynamos for supplying current to the air compressors, the deck machinery, windlass and winches and for lighting the accommodation. The mizzen mast is used for the motors' exhaust, and the main mast is arranged as a smokestack for the galley.

The accommodation is very ample and rather luxurious, fitted up for the passengers and officers. There will be cabins

Performance of the U. S. Collier Neptune

In July last year the United States collier *Neptune*, after having undergone her official speed trials, was temporarily taken over by the Government, subject, however, to the subsequent fulfillment of contract requirements.

Referring to an article which appeared in this journal of October, 1911, it will be noticed that, according to contract, an average speed of 14 knots must be maintained on a continuous 48-hour trial under full-load conditions inclusive of certain other weights, and that the coal consumption for all purposes must not exceed 1.8 pounds per indicated horsepower per hour, figured on the power developed by the main engines. At the trials referred to the average speed obtained was 12.926 knots, the collective brake horsepower of turbines 5,409, or the equivalent indicated horsepower 5,879, and the coal consumption 1.791 pounds per indicated horsepower per hour.

The unsatisfactory results were attributed mainly to very inefficient screw propellers, and possibly to inadequacy of the turbines. It will be recalled in this connection that the ship in question is fitted with a mechanical reduction gear, as finally adopted by the Westinghouse Machine Company, operating in conjunction with a new type of Westinghouse marine steam turbine. As a preliminary step, with a view to remedying the failure in fulfilling the requirements, it was decided to make new screw propellers, which were laid down by the Bureau of Steam Engineering, Navy Department, from a design directed by Capt. C. W. Dyson, U. S. N. In the trials performed recently with the new propellers the results obtained were most satisfactory, both as to speed and coal consumption. The principal differences between old and new propellers will be found in the comparison appended below:

	Old Propellers	New Propellers
Type	Built Up	Solid
Number of blades	4	3
Diameter	14 ft. 6 ins.	14 ft. 8 ins.
Pitch	12 ft. 6 ins.	12 ft. 1 in.
Projected blade area	61 sq. ft.	50.68 sq. ft.

Trial results	Old Propellers	New Propellers
Speed	12.926 knots	14 knots
Revolutions per minute	119.5	131.7
Coal consumption per I. H. P. per hour, turbines only	1.791 pounds	1.63 pounds
Shaft-horsepower	5,409	5,980

Maximum speed attained with new propellers was 14.24 knots, with a corresponding shaft horsepower of 6,310. The propulsive efficiency figures out about 65.6 percent. The higher number of revolutions per minute with the propellers aided materially in enhancing the steam economy of the turbines, and therefore a reduction in coal per horsepower.

Steamship Cap Finisterre

We show herewith a view of the steamship *Cap Finisterre,* the latest addition to the Hamburg South American Steamship Company's fleet. Built by Messrs. Blohm & Voss, Hamburg, she is of 16,500 gross tons, and is by far the largest vessel engaged in the River Plate trade. She is 560 feet long and 65 feet breadth, driven by two quadruple expansion engines of 11,000 horsepower, which will give an average speed of 17 knots. Her passenger accommodation can be compared with any of the modern New York liners. The first class staterooms, which are situated amidships and extend over six decks, are particularly lofty and well ventilated. The dining room calls for special comment, introducing an entirely new feature in its construction; for while the saloon occupies the full breadth of the vessel, it is carried upwards through two decks, thus giving the passengers the impression that they are dining in a lofty banqueting hall on shore. Furthermore, there are a splendidly arranged smoking room, a drawing room, a dining room for children and a winter garden. In addition to this there is a large swimming bath, air and sun bath, gymnasium, hothouse, dark room for photographers, etc. Another provision conducive to the comfort of passengers is the introduction of anti-rolling tanks, which have been proved to practically eliminate rolling even in the most severe weather. Besides the first class accommodation there is an excellent second class, a second class A, and the steerage. The steamer left on her maiden voyage from Hamburg to the River Plate Nov. 20, 1911.

HAMBURG SOUTH AMERICAN LINER CAP FINISTERRE

Progress in Freight Handling

In referring to the progress in freight handling the *Engineering Record* comments on the handling of freight in the terminal of the Missouri, Kansas & Texas system at St. Louis. It says:

"From time to time the mechanical handling of freight has been strongly urged, but it was only recently, after Mr. H. McL. Harding took up and pushed the telpherage system of overhead conveyance, that mechanical handling of package freight was really given careful study. Perhaps one reason for the delay has been the rather unfortunate observation frequently made, particularly in Europe, where mechanical handling equipment is more extensively used than here, of the tendency to shirk labor where a machine is at hand. Anybody who has observed a couple of German crane hands, as husky as wine vats though far less interesting, attach the hook of a 6-ton traveling crane to a 100-pound package, and thus move it 20 feet, is not likely to be wildly enthusiastic over labor-saving machinery of this sort. First impressions are pretty strong, and so many transportation men have seen such accurrences in Europe and in England that a feeling of distrust of machinery as an aid to economy has arisen.

"In any case of self-evident possibilities for reform it is wise to get away from prejudice, and fortunately any freight official can now take a stop watch and see for himself what mechanical handling will do. At the time when Mr. Brandeis was telling the Inter-State Commerce Commission that railway operators knew nothing about economical methods of handling freight, the American railway world was watching with deep interest the construction of the freight terminal of the Missouri, Kansas & Texas system at St. Louis. Mechanical handling of the same sort had already been used successfully at one of the wharves of the Baltimore & Ohio Railroad, but there was not enough freight at that point to give it a real trial, and so the St. Louis experiment was regarded with deep interest. The terminal was put in service on June 1. The very first day the teamsters tried to block the station by delivering about 25 percent more freight than usual. It was all handled without a hitch. Since then the station has been doing better than was expected so early in its service.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Needless Faults in Engine Room Design

It is a pity that many engine designers have had little or no sea experience. If they had sea experience they could improve the layout of the engine room, simplify the general arrangment, and make a more simple, efficient and satisfactory pipe plan. The writer finds it of incalcuable value to take a trip to sea once in a while to study conditions and note changes and otherwise obtain useful information, and it would pay any designer of both hull and engine to do likewise.

While making some tests on the steamer M———, the writer was impressed by the utter lack of appreciation of the requirements of service conditions relating to water service. This ship was designed and built by one of the most famous yards in the country. The engine was a triple expansion and there were two Scotch boilers. On the starboard side and bolted to the aft bulkhead of the engine room was a manifold containing eight valves. Connected to this manifold was the water service connection. If by any chance whatsoever all valves were closed, the engine water service was out of commission.

One morning the writer was taking data on the 4 to 8 A. M. watch, and had just gone around the engine feeling the bearings and taking notes. After making the rounds, he by mere chance felt the No. 6 bearing again and found it warming up. In less time than it takes to tell it, the bearing became very warm, and in removing the oiler on the top of the bearing cap and reaching down the writer felt the shaft and found it hot. The cock on the main service pipe was open but there was no circulation of water. We were at the time off Winter Quarter Shoal Lightship. The deck was notified that we would be compelled to shut down for a few minutes, due to hot bearings. The cap was eased off and the writer jumped for the strainer box, which was about 4½ inches square, and was located next to the bulkhead on the port side of the engine room. Upon opening this strainer a small crab fish was taken from it, the strainer was cleaned and replaced, and the bonnet put on. Heavy oil was used for the rest of the run on bearing No. 6. After arriving in port the cap was removed and it was found that the metal had dragged. This, of course, meant scraping the bearing, and as the pins and main bearings worked on thirty-six leads it was some time before this bearing could be put to this lead.

Now the thing that presents itself is this: Why should a water service be connected to a manifold where, by the merest chance, all valves could be accidentally closed? Why put in a small strainer? Is it not as well to put a separate connection for water service with a large and ample strainer in the line? It would cost more, but this ship was delayed two hours and the work on the bearing meant that other work was delayed. A water service should be a separate and distinct system and should receive very careful consideration, especially when it is in service all the time for bearings and guides, as these were all water cooled. If this designer had been to sea, and had realized the importance of the subject, he would have planned a different arrangement. If a seagoing engineer who had known his business had been inspector the chances are that it would have been different.

There is another thing which many engineers have to contend with, and that is inaccessibility of auxiliaries. In this ship the circulating pump and the engine were so close to the bulkhead that one would have to run the risk of loosing an arm in trying to feel certain parts, and hence it was often taken for granted that it worked cool all over; in any case it was squirt oil all around and trust to luck that it found the hole. There was ample room to place this very important auxiliary in an accessible place, and doing so would have saved copper pipe, which in itself is an item. The donkey pump was placed on the upper grating, of course, on brackets or a foundation made up of plates and angles, but placed so close to the engine-room casing that to pack it without removing a panel of the casing was impossible.

Another very objectionable thing was the location of the expansion joint on the main steam pipe. The aft end of the boilers projected into the engine room, which is common practice and sometimes necessary, but the expansion joint was placed near the stop valve on one of the boilers, instead of between the boilers, as it might have been placed, as there was plenty of room between the pipe and the bulkhead or screen to enable a man to pack it. As it was, it was a most difficult job to pack, and in hot weather was a very undesirable job. If the man who designed it was made to pack this joint in southern latitudes, and in the month of July, as the writer did, I can assure him he would certainly have changed it.

Now why do these things occur? Simply because either the designers have never had sea experience or they do not stop to think. A general arrangement is only a general arrangement when it is good, and it is only good when it considers ways and means of simplifying the handling and maintenance of machinery at sea. Auxiliaries must receive a lot of attention and they will receive it only when they are accessible. They can usually be located properly during the design and building, although the average designer has an aversion to the practical engineer, but I have found that the very best results have been obtained when he has been consulted. The practical engineer may not be able to compute the design or delineate it, but he can give his ideas, which, from practical experience, are worthy of great consideration, and the writer has found that the criticism of his designs by practical engineers, as well as his own experience at sea, has simplified and improved design with a corresponding increase of efficiency and satisfaction. And I further say that there are ships to-day which can be made very efficient by changes which would pay for themselves in a very short time, and if the present engineer is not capable of handling it satisfactorily there are plenty who are and not only anxious to improve conditions for themselves but to show the owner returns.

CHARLES S. LINCH.

Some Notes on the Breaking of Shafting

The following notes are an attempt to offer a reasonable explanation of the breaking of tail shafts and propeller shafts which occurs so frequently and for which it is sometimes difficult to put forward reasons. It is not the intention of the writer to convey the idea that the suggestions given solve the problem, but rather that marine engineers and those interested in marine engines may be assisted in forming conclusions upon which they may base their remedy.

A curious property of broken shafts is that they are often

highly magnetic, and if the reader, at the first opportunity, tests a broken shaft with a compass needle he will be able to verify the statement. It is not, however, remarkable that a mass of steel should have an effect on a magnetic needle, but it is found that the broken faces of the shafting show *like* polarity. If we take an ordinary bar magnet, say a magnetized knitting needle, for example, and break it into three pieces, we will find that we have three magnets each with a north and each with a south pole. But we never find, when we have broken the magnet, that the two adjacent faces of fracture have the same polarity. Thus, although the shaft is magnetized, its magnetism, or, if we may say so, the disposition of the molecules, differs from our usual experience of magnetized bodies. It has been stated that shafts have been found in such a condition that they were magnetic enough to support spanners, bolts, etc., and that if a handful of rivets were thrown at the shaft many would stick to it. Shafts as highly magnetized as this, however, do not appear to be common, although in almost every case distinct polarity can be detected.

A curious point in connection with this is that nearly 80 percent of the failures of shafting take place in the Atlantic trade. The fact of the prevalence of heavy weather in this trade, and that ships often run out light accounts for some of this, but is it not possible, applying our theory, that as the ship is running east or west, and therefore her shafting cutting the earth's lines of force just like the armature of a dynamo, the effect the currents produced may show itself in the molecular disturbance of the metal. Should this be the case, an effectual remedy would be a coil of wire, not necessarily a large one, through which a current was passing round the shaft. Such would have the effect of keeping the polarity of the shaft constant. The only reason that the writer offers for this peculiar relation between magnetized metal and weakness is that the magnetism has an effect on the molecular structure which may be something akin to fatigue. It is not necessary that such magnetism as a shaft may possess be acquired when in use. It is found that if a shaft is forged lying in a north or south direction it has a strongly marked polarity. Such may explain the magnetic condition of steam hammer piston rods which so often break. In forging, shafts are often fractured through insufficient heating during the process. When the outside of the shaft is hammered and thus stretched the inner portion is stressed and sometimes this stress is sufficient to cause actual fracture. Unfortunately such fracture is invisible and the outside appearance of the shaft gives no indication of its presence. This form of weakness in shafting is often brought about by lengthening shafting. In these days, when so many ships are built after the same model, it is the practice for ship engineers to stock shafting and, in lengthening a portion which they have in stock, insufficient heating during the process often causes serious internal stresses.

In one case, some time ago now, it was found that a ship was constantly breaking her propeller shaft and with a view to strengthening the diameter was increased. Curious as it may seem, this did not improve matters, but rather made them worse. The reason was not evident, but yet was not complicated when discovered. In this instance the ship was weak and in a seaway was liable to bend. As the shaft had to bend with the ship the larger it was made the more liable it became to fracture. This is plain when we remember that the strength of a shaft in torsion varies as the cube of the diameter, while its longitudinal rigidity varies as the fourth power of the diameter. Any increase, within practical limits, will not prevent the ship from bending, and, since the shaft must bend with her, the stress on it will be increased.

An interesting case is one where a dynamo used for ship lighting broke the shaft with persistent regularity. The dynamo was placed athwartships and in bad weather the engineers were accustomed to look to it for trouble. It was suggested that the machine should be shifted so that its shaft lay in a fore and aft direction, and on carrying out this suggestion the trouble was removed. The explanation was that the armature of the dynamo, running at high speed and having considerable momentum, acted as a gyroscope. The principle of the gyroscope is that a wheel, revolving at high speed in a given plane, tends to remain in that plane and resists any force which is applied to alter the plane of rotation. This resistance takes the form of a force at right angles to the applied force. In the above case the applied force was the rolling of the ship and the reaction was sufficient to break the shaft of the dynamo. By placing the axis of rotation at right angles, as it were, to the direction of the applied force the effect was eliminated.

The foregoing notes may be sufficient to show that the reasons for many bewildering troubles the marine engineer is confronted with are hard to find, yet interesting when found. Some of the theories given may be considered too imaginative, but imagination is necessary in solving all problems. Above all, what is more necessary than imagination, is reasoning, and marine engineers must learn to look farther than common reasons for uncommon results. In this a small amount of technical knowledge often counts for more than years of experience, and, what is more, leads to an understanding of the principles, which underlies the cause and the effect. I. R. Thomas.

Newcastle-on-Tyne.

Milling the Links of a Stephenson Valve Gear

During the slack season, when orders were few and far between and machinery depreciating, more rapidly, through lack of employment, we determined to launch out in a new field, in which there seemed to be an opening, to at least keep our staff employed until trade brightened up.

Our factory was situated close to the shipping quarter, but as business in our own line had hitherto been brisk little attention was paid to that fairly remunerative line, ship repairing, so, to hustle things up, we made bids for all sorts of jobs in that direction, and one of the first to turn up nearly floored us, as there was no machine tool in the factory capable of taking the job, namely, "truing" up the links of a Stephenson value gear with a radius of fourteen feet. However, as our motto is, "Ever onward," the bid was taken and brains puzzled how to do it when our foreman hit upon the idea that carried us through in good style.

Near one of the planers was the foundation of a drill press, which had been moved to a more convenient position, so this was utilized as a center on which to erect a table to carry the hub and radial arms of our design to effect the work on hand.

A piece of steel shafting was cast into a block of iron and the whole thing squared up in the lathe. On the base of the cast-iron block four bolt holes were cored to centers to correspond with T slots in the table erected on the old site of the drill press. The whole thing was then set up to the center line of the planer, an old pillow block was found to fit the steel pin, to which we built up two arms of channel iron to a radius of fourteen feet, measured from the center of the pin to the center line of the links.

The links were leveled up on two smooth blocks of cast iron and squared to the surface of the planer table; then the radial arms and center piece were squared to the links as they lay on the planer. When all had been set up fair and true the bolts were drawn up tight and the whole thing made fast, so that it resembled the segment of a flywheel. A milling attachment was rigged up on the tool post of the planer

and set to take a 1/32-inch cut, which was all that was necessary to true the face on that side.

To find feed motion a piece of a gear wheel was cut out and pinned on to the radial arms. This was geared to a lathe train of wheels to give a feed speed of about ¼ inch per revolution of the milling cutter, as we were anxious to avoid chattering, which would probably have set up at a high speed, owing to the long reach and the insecurity of the fixture.

The whole thing was run over and the cutter started with the feed gear in motion. Everything worked smoothly. When the top was finished a packing piece was added to the back of the milling attachment to bring it out to the inner radius and set to skin the metal, as it was not so far out as the outer radius.

We had the satisfaction of turning out a good job, while the arrangements ate up most of the profit. There was a margin left which justified us in accepting the overhaul, as since then we have had occasion to use the rig on similar jobs.

Dundee, N. B. C. F. M.

Broken-Down Circulating Pump

On one steamer where I was engineer we had an independent circulating pump for each engine, situated on each side of the engine room, the port pump for the port engine and the starboard one for the other side.

They were centrifugal pumps, and the vane shaft was in line with, and connected to, the shaft of a single cylinder, vertical, engine, twelve-inch stroke. It is necessary to tell the foregoing as it is with the engine that the breakdown occurred, and as the pump could be operated only by the engine a breakdown one way or the other shut that unit off altogether. To counterbalance this state of affairs there was a by-pass valve on the discharge side of the harbor gynne, whereby water could be pumped through the main condenser by this small pump, instead of through the harbor condenser, on the starboard side, and a discharge from a donkey pump on the port side.

Everything had been going well on this trip until one morning, just before relief of the twelve-to-four watch, the starboard engine slowed up, and a glance at the gages showed the vacuum gage quickly approaching the zero mark.

Steam coming from the starboard side of the engine room brought the senior engineer of the watch around to that point, when he found the starboard pump stopped. The relief engineers, coming on watch at this time, tried to get the engine going, but with no success. The starboard engine had been almost stopped by this time, word being sent up to the bridge to that effect, and progress being made "on one leg." The broken pump was shut off, and the harbor pump, the connections of which I described above, was started. Being a much smaller circulating pump than the broken main unit, it was able to hold anything like a vacuum only when the starboard engine was going slowly, due to the impossibility for it to condense such a large volume of steam, passed through on full speed.

A hurried feel around the pump and engine disclosed no overheated bearings or parts, so we again tried to lever the crank wheel over, but she would not "go over" the bottom center, although there was no obstruction in the crank pit. The engine would go round each way until it came to about an eighth of the crank circle radius on the bottom, when nothing would fetch it over, so it had to be opened up.

The cylinder cover was removed, as also was the piston, when the neck bush was found in a dozen pieces. The piston and crosshead had to be taken out through the bottom cover as it was all one forged piece, and a search was made for the spare neck bush, with no result, however, as the one which had just given out had been renewed only a short time before, and a spare neck bush had not as yet been shipped on board. The neck bush had a collar on the stuffing-box end, and this collar must have been broken off or the bush could never have found its way into the cylinder. I take it that the gland may have been allowed to remain unscrewed a little and that the bush was a trifle slack in the bottom head and the whole packing resting on the top of the gland allowed a certain free up and down movement of the bush with the present result: One turn of the engine would bring the neck bush into the cylinder, as it was a split one on account of the shape of the rod, and the two halves falling apart brought the engine to a stop on its bottom center but with a disastrous effect to the bush. There was no apparent effect on any other part of the engine, and this was due to the fact that this class of pump does not require a very great speed to lift the circulating water in quantity.

A repair had to be made and soon; but as we did not have a spare bush on board we fixed it up this way. Two washers were made out of ⅛-inch iron, the diameter a little more than the stuffing-box, and a hole the diameter of the piston rod. When these were fashioned we cut them across the centers, splitting them. We now filed them to fit the rod and stuffing-box and put the first on in the box just a nice snug fit with the split fore and aft. The next washer was put in, split on the square of the other, athwartship. This made a good solid bottom for the packing, which consisted of a hard bottom turn and a filling of the usual kind. The longest job was taking the engine apart and making these washers. It did not take long to reassemble the parts together again, and I think you can guess the job was a good one and the only kick I had was because the circulating pump should have given out when we were on the hottest period of our journey in July. H. W. H.

International Safety Congress

The new American idea of the Safety Engineer, an accident prevention specialist, will be brought to the notice of world industrialists at an International Safety Congress to be held in Milan, Italy, for five days, beginning May 27, 1912. This Congress, the first of its kind of international scope ever held, will be for the purpose of setting in motion a world-wide movement for the conservation of human life in industry. The American Museum of Safety, 29 West Thirty-ninth street, New York, is making preparations so that the United States will be well represented. An American National Committee has been selected by the American Museum to co-operate with the International body and to promote the American ideas and views at the Congress. Dr. W. H. Tolman, director of the American Museum of Safety, and other members of the committee will attend the Congress.

The following are some of the papers which will be read at the Milan Congress:

"The Safety Engineer on a Large Transportation System," by Dr. W. H. Tolman, chairman, American National Committee.

"How the New York Edison Safeguards the Lives and Limbs of Its Employees," by Arthur Williams.

"The Work of the Safety Committee of the United States Steel Corporation."

"Safeguarding the Traveling Public and Protecting the Employees of the Electric Street Railway Association."

"Proper Illumination and Accident Prevention," by J. V. Lansingh, president of the Illuminating Engineering Society.

The Bureau of Navigation reports 68 vessels of 2,388 gross tons were built in the United States and officially numbered during the month of January. This included only one steel steamer, the gross tonnage of which was 125.

Review of Important Marine Articles in the Engineering Press

The German Submarine U 8.—According to Jane's "Fighting Ships" the U class of submarines for the German navy are divided into three classes—U 1 by itself, U 2, 3 and 4 and U 5 to U 12, inclusive. U 1 is reported to have a displacement of 180 tons and a four-cylinder petrol engine, which drives on the surface at 12 knots and 9 knots submerged. The boat is said to have a length of 128 feet and 9-foot beam. Of this craft little more is known and of the others practically nothing. It is apparent, however, that this boat has acquitted herself well, for announcement has been made of special honors given her commander and chief engineer by the Emperor. With the article are four photographs of the vessel carrying out evolutions at the surface. 360 words.—*The Engineer,* December 1.

The French Destroyer Bouclier.—Principal dimensions: Length over all, 233 feet 4 inches; length between perpendiculars, 230 feet 4 inches; extreme breadth, 24 feet 10 inches; depth, 16 feet 5 inches; mean draft, 12 feet 6 inches; displacement on trial, 660 tons. The hull is of high tensile steel, divided into ten watertight compartments. The freeboard forward is high, giving navigating officer good protection and enabling speed to be maintained in a rough sea. There are four Normand watertube boilers, burning oil. Working pressure is 228 pounds per square inch. Main engines are turbines, of the Parsons type, driving three shafts. Propellers are 5 feet 3 inches diameter, 4 feet 11 inches pitch, designed for 1,000 revolutions at full speed. The mean speed for six hours was 35.3 knots. Shaft horsepower for this trial 15,000. Bunker capacity is provided to give steaming radius at 14 knots of 1,950 miles. 1,100 words and photograph.—*The Engineer,* December 15.

Suction Dredge New Orleans.—There is being built for the Engineer Corps of the War Department by the Fore River Shipbuilding Company, at Quincy, Mass., a twin-screw suction dredge of the Fruhling type for service in the southwest pass of the Mississippi River. The head of the dredge is a large, enclosed rake, about 18 feet wide by 5 feet fore and aft, with sharp-cutting teeth, through which is injected water under high-pressure, thereby helping to disintegrate the soils and make it of suitable consistency to be readily sucked through the duplicate suction pipes. There are ten hoppers, with a combined capacity of 3,027 cubic yards, or 3,000 tons, which can be filled under favorable conditions in thirty minutes. The machinery consists of four sets of triple-expansion engines, arranged in pairs, tandem, and built on common bed-plates. The two after sets are commonly used for propulsion and the two forward sets for pumping, although the four sets may be coupled together for use in propulsion. Steam is generated by Babcock & Wilcox boilers. Material may be dumped through bottoms of hoppers or pumped overboard through a swivel discharging pipe for reclamation work, or into scows or other hoppers alongside. Principal dimensions are: Length over all, 315 feet; length between perpendiculars, 300 feet; breadth, molded, 50 feet; depth, molded, 26 feet; dredging depth, 21 to 50 feet; draft, loaded, 20 feet; speed, loaded, 10 knots. 950 words and photographs.—*Marine Review,* December.

The Austrian Battleship Zrinyi.—The greater part of this article deals with the present status of Austria as a sea power and how this country is coming to the notice of the nations. The battleship *Zrinyi* is one of the three latest to be built, the others of the class being named *Erzherzog Franz Ferdinand* and *Radetzky.* These vessels have unusually large armaments for their displacements, due to the milder weather conditions of the Mediterranean and Adriatic seas as compared with the rigors of the Atlantic, which must be taken into consideration by the designers of the first powers. Thus battleships in this rating belonging to the other navies have a knot or more speed and greater coal-carrying capacity. The principal dimensions for this ship are: Length, waterline, 448 feet; length over all, 456 feet; beam, 82 feet; mean draft, 26½ feet; displacement, 14,268 tons. The machinery consists of two sets of triple-expansion engines, designed for 20,000 horsepower and speed of 20 knots. Actual trial developed 20,600 horsepower and a speed of 20.76 knots. All three ships were built and engined by the Stabilimento Tecnico, Trieste, and completed between 1910 and 1911. 1,300 words with photograph, diagram and table of comparison.—*The Marine Engineer and Naval Architect,* December.

The Danish Torpedo Boat Soridderen.—One of the latest additions to the Royal Danish navy and designed especially for the shallow waters near that coast line. The vessel was built by Messrs. Yarrow & Company, and has the following principal characteristics: Length, 181 feet 9 inches; beam, 18 feet; two Yarrow watertube boilers built for a working pressure of 265 pounds per square inch, working Brown-Curtis turbines on two shafts. Each turbine casing has an astern turbine, thus facilitating maneuvering. In the official trials, in rough water, a mean speed of 28.28 knots was obtained with 5,300 shaft horsepower at 1,050 revolutions per minute. The consumption trial showed the vessel to have a radius of action of 1,400 miles at 14 knots speed. The article is accompanied by two page plates, showing general arrangements. 850 words.—*Engineering,* January 26.

The Armament and Protection of Battleships.—By the Hon. Salvatore Orlando, President, Italian Institute of Naval Architects. The author first outlines a number of advantages to be considered due to tactical reasons. Then follows the description of a design of a vessel which carries out these and other desirable principles. A point considered was advantageous arc of fire and best placing of batteries to secure it. Secondly, and at greater length, he considers the defense of the ship below the water-line. Recent experience has shown that under-water explosions are more dangerous horizontally and downward than upward, and that excessive forces diminish rapidly with distance from their center of action. It is urged that protection against such attack be placed as near amidships as may be, the side of the ship having little real armor. This, with the reducing in size of all watertight compartments, is considered the most effective means of safety in time of disaster. Triple bottoms are not considered desirable enough to warrant the increased height of the ship produced. The vessel's stability under damaged conditions is shown by drawings and by results of stability calculations. The principal dimensions of the ship designed as an example are: Length between perpendiculars, 512 feet; extreme beam, 91 feet; draft, 26 feet; metacentric height, 23 feet; speed, 24.3 knots; main battery, eight 13.5-inch guns. Propelling machinery consists of turbines on three shafts. Boilers are in three groups, each with its own funnel. Bunker capacity is 2,000 tons of coal with tanks for 600 tons of fuel oil in the double bottom. Illustrated with drawings. 2,600 words.—*Engineering,* January 12.

Depth of Water on Measured Mile.—A valuable contribution on the subject, containing practical rules whereby navigators may know when their ships are in waters of uneconomical depths. Contains a synopsis of several previous articles giving results of trials of ships on different measured miles with widely varying results. Well-known examples are those of the United States battleship *Michigan* and the tor-

pedo boat destroyers *Flusser* and *Reid* on the Delaware Breakwater, Provincetown and Rockland courses, trials of the British torpedo boat destroyers of the river class, and later of the *Tribal* class on different courses near the English coast. Additional information is furnished by extracts from a paper by Prof. H. C. Sadler on "The Resistance of Some Merchant Ship Types in Shallow Water," read before the Society of Naval Architects and Marine Engineers last November. The article contains plots of horsepower to base speed of ships similarly loaded on different courses and formulæ for computing favorable depths of water. 3,000 words.—*The Engineer,* January 26.

The Hydraulic Interaction Between Passing Vessels, Called Suction.—By Sidney A. Reeve, M. E. An investigation from the viewpoint of a consulting engineer of the court records available of collisions of vessels due to suction. Some of the later instances are familiar to those who have followed marine history for some years. The causes of these phenomena are then explained by reference to certain well-known principles of hydraulics, a simple illustration of which is found in the Venturi meter. From these theories, the author takes facts gathered from a recent example of the action of suction between vessels (and plots wave diagrams). From these he shows analytically why the vessels in question collided and why these two examples were especially susceptible to danger. These results are then compared with those of Naval Constructor D. W. Taylor, whose experiments were conducted in the government tank and whose results were presented to the Society of Naval Architects and Marine Engineers in 1909. The work agrees in substance with the theories outlined by the author. No results are given to show how near passing vessels may approach each other without danger. 9,500 words with diagrams.—*U. S. Naval Institute,* December.

Development of the Marine Boiler in the Last Quarter Century.—By George W. Melville, Rear Admiral, U. S. N., Retired. A careful review of the author's efforts toward the adoption of watertube boilers in the United States navy. At the time the author began his work as engineer-in-chief the watertube boiler was not used in the navy. Its adoption in a few instances in very small vessels was not considered conclusive proof of its desirability for large ships. With much effort a trial was arranged, and watertube boilers were installed in the *Monterey* and *Cushing.* Since that time its use has grown rapidly until now practically all naval vessels are so equipped. The author names the following characteristics of any thoroughly satisfactory watertube boiler: Reasonable lightness, with scantlings sufficient to promise reasonable longevity; an adequate amount of water, so that failure of the feed supply or any inattention thereto would not immediately cause trouble; accessibility for cleaning and repairs on both water and fire sides; straight tubes, with no screwed joints; no cast metal, either iron or steel, subjected to pressure; ability to raise steam quickly; high economy of evaporation; economy of space; interchangeability of parts, and, as far as possible, the use of regular commercial sizes for facility of repairs; the ability to stand severe forcing without injury; the ability to stand abuse, of rugged construction, and not so delicate as to require skilled mechanics to run it; safety against explosion, meaning that only the part of the boiler which gave way would be damaged. Several types have been found that satisfactorily fill these conditions, with the result that naval boiler plants are high in efficiency and capacity. The author expresses surprise that the watertube boiler is not much more used in merchant practice, where so large an item in weight might be saved. The article is accompanied by tables of tests on both watertube and cylindrical boilers, giving much valuable data for design and operation. 5,700 words.—*The Engineering Magazine,* January.

Some Impressions of Continental Marine Diesel Engine Practice, No. 4.—It may be hard to become enthusiastic about the status of oil engines for marine purposes in a country where little has actually been done, but when visiting in the shops in countries where literally dozens of engines of this type are being built and installed in various craft, from submarines to cruisers, it is more easily realized that the internal-combustion engine for use of heavy oils is beginning to come into its own, and that soon. The author of this article shows what is being done in two shops on the Continent, and makes general comparisons with work in others. He describes in some detail the Sabathé motor, which recently passed through the Admiralty tests of ten hours' duration with the remarkable fuel consumption of 0.38 pound per horsepower-hour. He also takes up the work of Scheider & Company, of Le Creusot, and describes an 8-cylinder, 4-cycle engine for submarines, which turns at 400 revolutions per minute and weighs about 67 pounds per horsepower. He sums up the situation for European builders by giving the following achievements: 6,000 horsepower on one shaft, 2,000 horsepower in one cylinder, 1,250 horsepower already running, and 1,000-horsepower engines almost a common thing. 3,600 words.—*The Engineer,* December 29.

Propeller Erosion.—An account of the metallurgical difficulties experienced in service with high-speed turbine propellers. Formerly some similar actions were reported on wheels driven by reciprocating engines, but these were overcome by substituting bronze for steel. In this article a detailed account is given of the finding of a new metal which is not affected by the serious conditions at present encountered. The work was undertaken by Dr. O. Silbarrad, of the Silbarrad Research Laboratories, Buckhurst Hill, Essex, who had already carried out some similar work for the Admiralty. Although at first the research was not encouraging, an alloy was found after an enormous number of specimens had been tested which has proved satisfactory. The name Turbadium has been given this, and it has been used on the *Mauretania* for six months' continuous service without showing signs of erosion. It is stated that orders have been filled for large propellers for foreign navies as well as for the British Admiralty. The article is well illustrated by photographs of propellers showing erosion. 2,500 words.—*Engineering,* January 12.

The Internal-Combustion Engine at Sea.—An editorial discussion of the gas and oil-engine in large sizes for marine purposes and ways of making them more practicable for such use. "We are, no doubt, still far from the realization of the long-standing prophecy that the steam engine is to be ultimately relegated to the museum of mechanical curiosities; but so far as high-speed launches are concerned the victory of the internal-combustion engine is hardly disputable, and debate now centers on its suitability for larger craft. With existing types of motor, however, it seems hardly probable that much success will attend the system where really large powers are required on a moderate displacement." Following this is a comparison of weights of machinery installations for both systems, in which the internal-combustion engine compares very favorably with the average large-size commercial steam marine plant, but quite the reverse when compared with high-powered, high-speed craft, as in torpedo boat destroyers. Under the subject of fuel, the oil engine is given the preference. It is suggested that this solution might not long hold if oil fuel became in general demand. The attendant rise in prices might overcome whatever advantage now lies in its cheapness. At present the mechanical features of the internal-combustion engine are against it. "Hitherto the problem has been attacked mainly by 'erudition' rather than by 'invention.' The Diesel engine and the large gas-engine are essentially the productions of men who have been taught to apply theoretical

principles to the ordered development and improvement of previously existing types of prime mover. It is, however, most probable that the ultimate solution of the marine gas-engine will be found in some entirely different direction of development, since it is difficult to see any possibility of substantial further improvements along the paths hitherto chosen, the possibilities of which have been pretty exhaustively exploited." 2,000 words.—*Engineering*, January 12.

The Diesel Marine Engine.—By Herr Th. Saiuberlich. The last of a serial on this subject. The first part of this instalment speaks of the cast parts from the founders' point of view, and describes mechanical features of the motor. Towards the end practical comparisons are made between performances of the Diesel motors and steam plants, especially in the cases of the North Sea fishing boats, where many of these engines are used with economic results. It is claimed that their introduction will mean much toward the up-building of the German herring fisheries. An example of increased economy by the adoption of this engine was in a fishing boat which can now carry 160 casks of herring more than before and go 1½ knots faster. Several illustrations of mechanical details. 4,000 words.—*The Steamship*, November.

The Carels Diesel Marine Engine.—A brief description of a recent two-cycle, four-cylinder engine built by this well-known firm at Ghent. The engine is single-acting, and is capable of burning the heaviest oils on an economical consumption. The structure of the engine is similar to an ordinary marine steam engine and calls for no comment. The cylinder heads contain valves for fuel and air inlet and also scavenging valves, of which there are four for each cover. Compressed air is supplied by a three-stage compressor worked by the main shaft forward. All essential control gearing is interlocked, making them impossible to operate in any but the correct sequence when stopping or reversing. 1,000 words, illustrated.—*Engineering*, January 19.

A Thirty-Day Non-Stop Run of a Marine Oil Engine.—The principal objection to marine oil engines of any size has always been non-reliability. It might be hard to prescribe a test that would prove the presence of reliability of working in any engine, but in any case such a run as was recently made in the shop of Barclay, Curle & Company shows that the engine under trial could run satisfactorily much longer than any sea trip would require. Recently this company built a single-cylinder model of an engine to be built for the *Jutlandia*, and tested it with a thirty-day non-stop run. The size of the cylinder was 22 inches diameter and the stroke 29¼ inches. The engines for the ship mentioned are to be eight-cylindered, and are designed to give 1,250 horsepower. Careful records during the test showed the consumption to be 0.45 pound per brake horsepower, and the maximum horsepower 126 at 143 revolutions per minute. The cylinders and rings were in very good condition after the run, and gave no indication of being unable to continue the test. 2,500 words.—*The Engineer*, January 26.

Cylinder Condensation.—An editorial discussion of a paper on this subject by Prof. Mallanby, D. Sc., read before the Institution of Engineers and Shipbuilders in Scotland on Nov. 21. The whole subject is one of primary importance to steam engineers, and has to do with the discovery of the missing quantity of steam in an engine cylinder. Three possibilities are open: First, that Regnault's steam tables are wrong; second, steam may leak through the engine; third, condensation may be much higher than is generally supposed. This latter possibility is the one favored by the editors, and their contention is based upon the claim that condensation depends upon temperature of the cylinder walls at the instant of admission, and not on average temperature of the metal of the cylinder for the whole cycle. The manner of heat transmission intermittently to and from walls is not known, neither are the accurate temperatures of the surfaces involved—and even less, the volumes and temperatures of clearance spaces. With this data missing little definite can be known. 2,400 words.—*The Engineer*, January 19.

Latest Development in Condensing Systems.—By J. B. Howell, U. S. N. A study of fundamental conditions met with in condensing systems followed by examination of three systems in present use to best meet requirements of present-day usage. First, the Dual air-pump system, developed by G. and J. Weir Company. This consists essentially of a wet air pump working at a temperature due to the vacuum in combination with a dry-air pump working at a much lower temperature. The other two are developed by Mr. D. B. Morison and are known as the Kinetic Rotary Air-Pump System and the Bi-Therm Air-Pump System. The former consists of a steam jet, followed by a special system of water jets to remove air and non-condensible gases, while the latter is a compromise between the dual and the kinetic systems and may be installed with present designs. In the article diagrams and drawings explain the action as well as the purpose of each type, and although not lengthy is clear and a suitable exposition of the subject. 4,700 words.—*U. S. Naval Institute*, December.

The Evolution of Lead-Lined Piping on Shipboard.—By R. D. Gatewood, U. S. N. First analyzes the results of galvanic action of sea water in pipes and states known means of preventing. Then gives the results of numerous tests by the Bureau of Construction and Repair as to the best means to adopt. Lead-lined piping has proved very satisfactory on trial aboard several ships. The author then describes method of making, and tests of the pipe made before using. It is claimed that this piping weighs 5 percent less and costs 50 percent less than the same installation of copper piping. Gives a list of points well known from experience with this method and cautions to be observed in its making. 7,000 words.—*U. S. Naval Institute*, December.

Engineering Works at the Rosyth Naval Dockyard.—The first instalment of a series of articles describing in detail the construction of the new naval dockyard authorized by Parliament and begun in 1909. The situation is on the Firth of Forth, and the land purchased for the site is 1,200 acres in extent. The contractors for the work are Messrs. Easton Gibb & Son., Ltd., and the progress they have made already speaks well for the early completion of the work. After dealing with the geological conditions of the work and showing its general scheme, the author describes in detail the contractor's organization and provision for the workers. Other topics covered are the temporary dams built, the concrete-mixing plant and the building of the walls. The article is accompanied by numerous illustrations and drawings which show the arrangement and progress of the work. 11,500 words.—*Engineering*, January 19.

Recent Progress in Warships and Machinery.—An editorial review of the shipbuilding progress of Great Britain during the year 1911, especially in the particular of new warships added to the navy. It is argued that the number and power of warships launched in a year is a good index of the provisions made to conserve sea supremacy of that nation. A careful list is given of the ships and class, where built and general characteristics as to power, speed, armament and armor. A table is included showing results of all steam trials made during the year in the navy. Mention is also made of the warships built in England for foreign powers. 5,000 words.—*Engineering*, December 29.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

This issue of INTERNATIONAL MARINE ENGINEERING marks the fifteenth anniversary of its publication. Originally the magazine was published in New York under the name of MARINE ENGINEERING, but for the last six years an English edition has been published in London coincident with the American edition, and the name of the magazine has been changed to INTERNATIONAL MARINE ENGINEERING. The policy of the magazine, however, has remained unchanged, for it has always been our purpose to place before our readers in a clear and concise form all matters of importance relating to the engineering problems of maritime commerce and shipbuilding irrespective of nationality. It is with pleasure, therefore, that we take this opportunity of expressing our thanks for the extensive patronage accorded to both our editorial and advertising departments, which has made possible our work in this direction.

No period of fifteen years has been so productive of far-reaching developments and progress in shipbuilding and marine engineering as the fifteen years just passed. At the beginning of this period one of the greatest triumphs in engineering skill had been attained in the creation of the express steamer, a type of ship which was destined to decide the supremacy of the seas, culminating in such splendid achievements as the *Lusitania* and *Mauretania.* Greater ships have been built, and are now under construction; but whether the present limit of speed in passenger steamers will be exceeded depends entirely upon future commercial and contingent conditions. Such a step is entirely feasible from the standpoint of the naval architect and marine engineer, at whose disposal are the steady and logical developments of engineering and industrial arts; but the question of whether or not the financial returns from the future progress of maritime commerce will permit the enormous expenditures entailed with the increase in speed can only be decided in the course of time. The present tendency in the construction of passenger ships is towards a greater number of large-sized vessels of moderate speed with large cargo-carrying capacity. With this there is also a tendency toward more general use of the intermediate type of ships, which are in reality fast freight ships with limited passenger accommodations. The question of size depends upon the harbor facilities and depth of approach channels, the deepening of which beyond present limits seems at present to be too costly. Another important item, which, so far, has received scant attention, is the improvement of freight-handling facilities at terminals to reduce the cost and expedite marine transportation. With interest awakened in this direction, the general conditions of over-sea trade will be fundamentally improved.

The rapid progress in marine engineering during recent years has been influenced chiefly by the questions of speed and economy. In merchant ships of moderate speed the long-established types of Scotch boilers and reciprocating engines have maintained their superiority, although they have been subjected to continual improvement in the perfection of details and the elimination of imperfections. As a result, this type of propelling machinery has reached a state of perfection beyond which, with the present resources of materials and methods of manufacturing, there does not seem to be much opportunity for greater improvement. On the other hand, the value of speed and the necessity of obtaining as good, if not better, economy with propelling machinery for high-speed vessels, such as express steamers and naval vessels, where minimum weights and other limiting conditions are imperative, have opened up a wider field for development in marine engineering in the last fifteen years than ever before. Oil fuel, watertube boilers, turbine machinery and the performance of high-speed propellers, together with the more recent developments of internal-combustion engines, have afforded an immense field for investigation and development by the highest engineering skill, so that better economical results can be obtained under the various conditions that must be met. As the present period is largely one of transition and elimination, the present tendencies in marine engineering do not warrant definite conclusions as to immediate future developments, although the greatest possibilities lie in the use of heavy oil internal combustion engines.

Improved Engineering Specialties for the Marine Field

A New Marine Watertube Boiler

The watertube marine boiler shown in the accompanying illustrations, is an entire departure from the generally accepted type of marine boiler, as the numerous headers and expanded nipple connections usually used are eliminated. There are absolutely no joints or connections except the ends of the generating tubes, which are expanded into the water legs or flitches.

These boilers are built by the Charles Ward Engineering Works, Charleston, W. Va., in two types and of varying sizes to meet requirements. Fig. 1 shows a boiler which is particularly adapted for vessels of limited height between decks and moderate forced draft. The steam and water drum is located over the front flitch and at the lower end of the tubes. Circulation is provided by large openings in the bottom of the drum, registering with the rectangular passages in the water legs, delivering an ample supply of water to the generating tubes. The return from the upper flitch to the drum is through the top row of four-inch tubes.

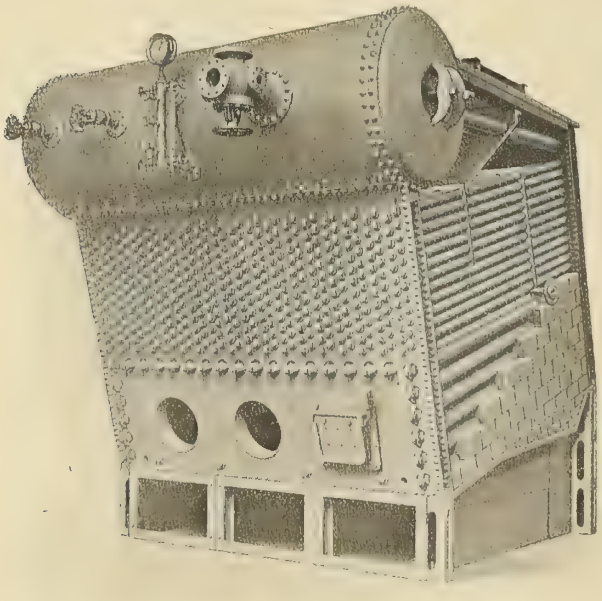


FIG. 1

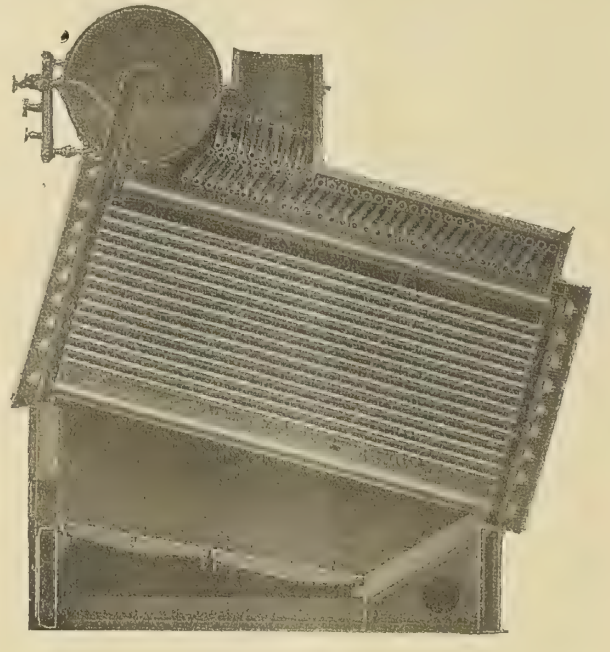


FIG. 2

The boiler shown in Fig. 2 has much larger passages for the circulation, and is designed for forced or natural draft and the greatest economy, having a superheater and a feed water heater. In this boiler the drum is in the front on the high side; the upper portion of the front flitch is enlarged where it is riveted to the drum; this chamber is divided by a diaphragm into two parts, one of them forming a passage from the drum to the large down-flow tubes, the other receiving the ends of the generating tubes, thus completing the circulation and delivering above the water line in the drum.

The water legs, or flitches, are constructed of steel plates, ¾ inch in thickness, forming the tube and hand-hole sheets. These sheets are spaced about 3½ inches apart, stayed to each other by improved and patented continuous stays, dividing the water leg into a number of rectangular passages, as shown in Figs. 3 and 4. T-shaped retaining grooves are milled in the tube and hand-hole plates approximately 6 inches from center to center. In these retaining grooves are fitted, in sections, a continuous I-section stay plate connecting the two sheets, thus forming the rectangular passages. This construction is claimed to be much stronger than any other method of supporting flat surfaces, as the connection is practically a continuous line, and the load per inch of stay is equal to the distance from center to center of the stays. multiplied by the working pressure, or only 1,800 pounds per lineal inch of stay for 300 pounds of steam, compared with 10,800 pounds per stay for the usual method of staybolting on 6-inch centers. Expansion and contraction is provided for by the flexibility of the stay plates, and the movement of the sectional stay in the retaining grooves. The troublesome question of leaky and broken staybolts is entirely eliminated, as there are no screwed or riveted stays in the boiler and no holes through the plates.

Each header, or flitch, in the moderate sizes, is constructed of one plate, folded through the center (Fig. 2), the edges channeled, flanged, or lapped and riveted, eliminating, as far as possible, all riveted joints, except the connections to the steam drum, which are flanged and riveted. Hand-holes covering a group of tubes, or individual plugs opposite each tube, give access for cleaning and renewals.

The steam and water drum is of large proportions, giving ample steam space and a steady water line. It is composed of one sheet, the joint being a very heavy butt strap, which insures the necessary strength where the drum connects with the front flitch, as large passages for circulation are provided at this point. The drum heads are bumped and fitted with a manhole at each end. The butt joints and heads are double riveted, all rivet holes drilled in place after the work is fitted, insuring fair holes and tight work.

The generating tubes are 2 inches outside diameter of extra heavy gage. The length is varied as required, depending on conditions. The down-flow tubes are 4½ inches outside diameter and No. 6 B. W. G. All tubes are expanded into the tube plates and the ends flared.

Feed water heaters and superheaters are furnished for either design when desired. As shown in Fig. 2, the feed water heater, located in the up-take, is of the long flow type, and consists of three headers with U-shaped tubes, the open ends expanded into the headers; the water entering the top header,

travels through the tubes full width of the boiler four times, and is finally conducted by the internal feed pipe to the bottom of the drum, discharging through jets into the down-flow passage of the front flitch, thus increasing the circulation. The superheater is of the same general construction as the feed water heater, with a shorter flow, and is placed over the top of the down-flow tubes as shown in Fig. 2. Ample provision for expansion, cleaning and renewals of the feed and superheater tubes, insures the most efficient and satisfactory results. By-pass valves are fitted on the heaters, permitting either, or both, to be cut out in case of emergency.

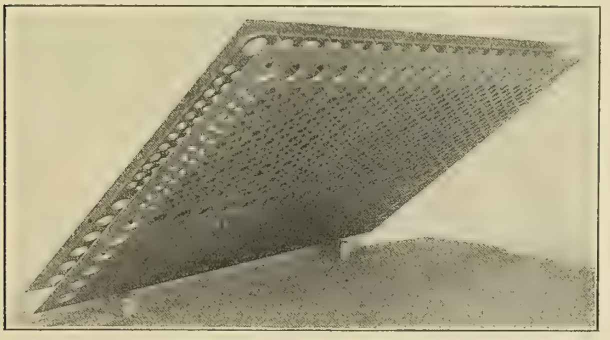


FIG. 3

The casing is sectional and lined with asbestos fire felt 2 inches thick. The furnace in Fig. 1 is entirely surrounded by the large side tubes and the flitches. The furnace door openings are circular and welded into the plates. Special fire brick, formed to fit around the outside of the side tubes, form the sides of the casing and are held in place by the sectional casing. In Fig. 2, the flitches do not extend below the tubes, and the furnace walls are of regular fire brick. The boiler is carried independently of the furnace walls, which can be rebuilt without disturbing either boiler or casing.

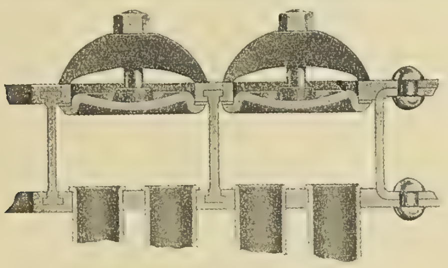
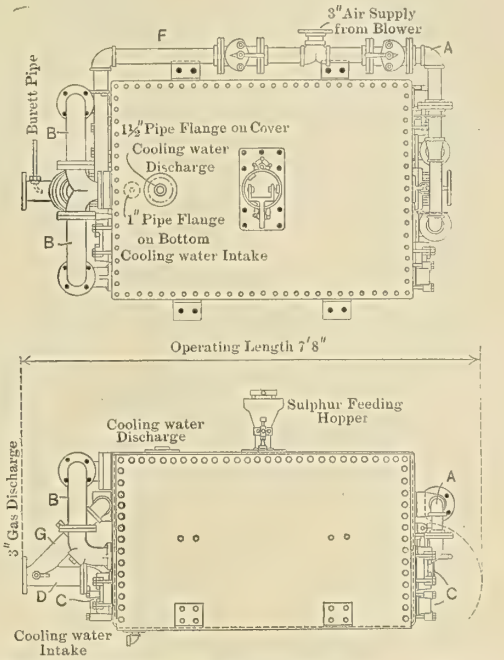


FIG. 4

A Fire Extinguishing Apparatus

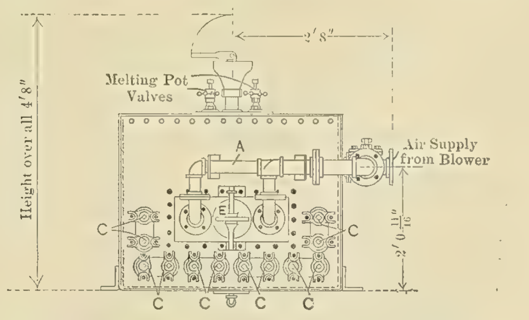
The problem of extinguishing a fire on shipboard as well as preventing one is a serious matter, because of the usual inaccessibility of most fires which occur in the cargo. Fire has smouldered for days and weeks in a ship's hold, while the crew have been unable to put it out. Especially so in cargoes of hemp, jute, bituminous coal and like substances. Steam may damage cargo and, under certain conditions, may help combustion. The ideal form of extinguisher in an inclosed space like the hold of a ship is a gas which displaces the air by its own specific gravity, and is itself a non-supporter of oxygen. This gas is found in sulphur dioxide, made when needed from ordinary commercial sulphur. An apparatus for generating sulphur dioxide has been placed on the market by the Fumigating and Fire Extinguishing Company of America, 29 Broadway, New York.

This apparatus, which may be used both for fumigating purposes and for extinguishing fires, consists essentially of a furnace, a blower and an engine. The whole apparatus may be located in a deck house or in any convenient position, or the blower and engine, with a tank for storing compressed air, may be placed in the engine room under the immediate care of the engineer.



PLAN AND ELEVATION OF FIRE EXTINGUISHING APPARATUS

The furnace in which the sulphur dioxide gas is generated is built on the principle of a marine boiler. As shown by the drawings, the outside is a rectangular tank, within which is a furnace. Sulphur is admitted into a melting pot in the furnace through a charging hopper on top of the apparatus. Two valves on each side of the hopper are used to regulate the admission of the melted sulphur from the melting pot into the furnace. Compressed air is carried to the furnace through pipe *A*, which connects with two perforated pipes in the furnace. The gas formed from the air and sulphur is conveyed from the top of the furnace through pipe *B*, and then passes back and forth through tubes *C*, which are surrounded by the water circulating in the outer jacket around the tubes and furnace. After the gas is cooled by passing through tubes *C* it is discharged through the pipe *D*, and is carried through a hose or pipe to its destination.



FRONT END VIEW OF FIRE EXTINGUISHING APPARATUS

When starting the furnace, the door, *E*, at the end, is opened and alcohol-soaked waste is placed in the furnace and ignited. The door is then closed and remains closed throughout the operation of the furnace. As soon as the door is closed the compressed air is turned on, part of it being admitted to the furnace through pipe *A*, and the rest being by-passed through

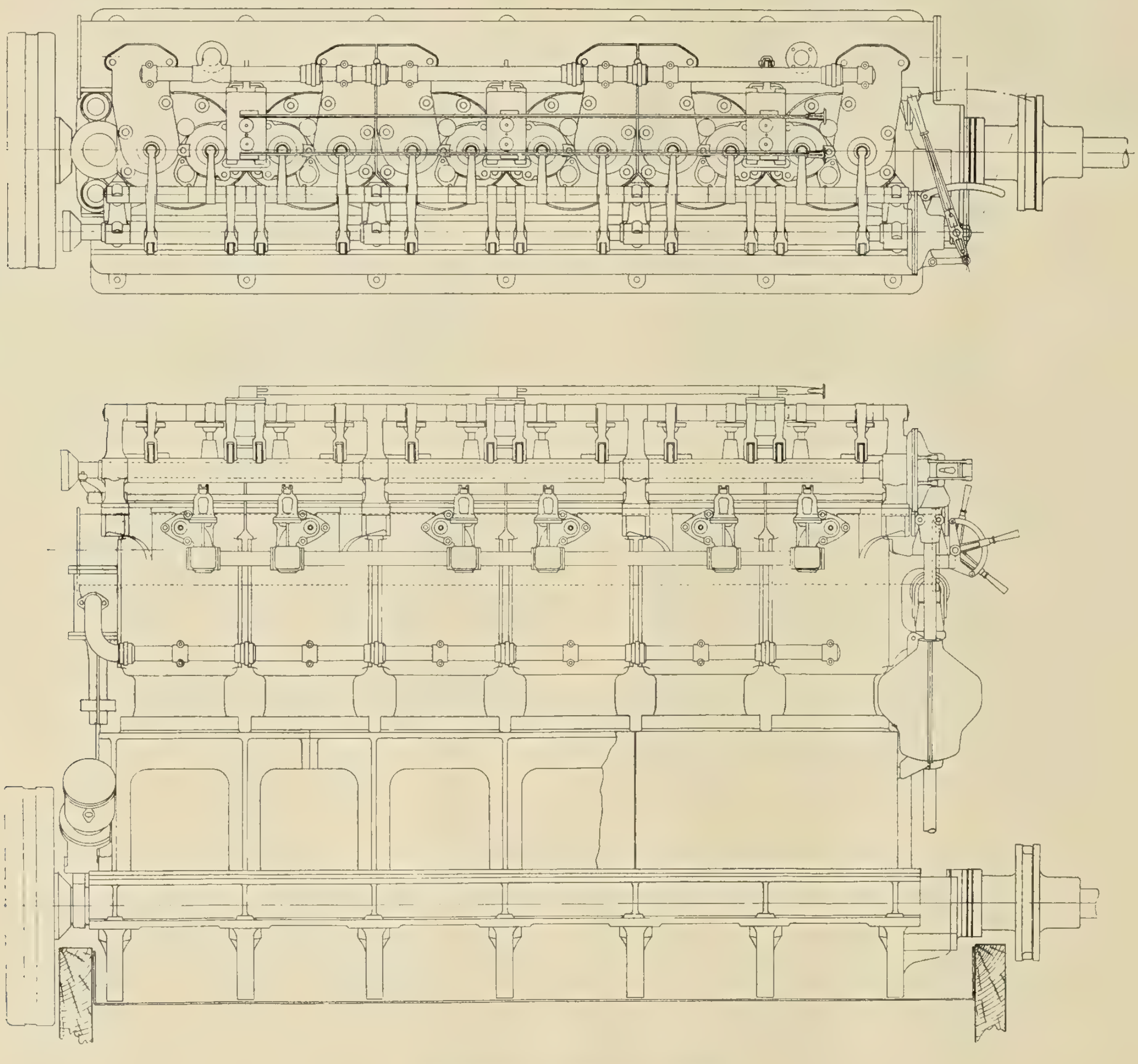
pipe F to the gas discharge pipe at G, thus acting as an injector and drawing the products of combustion from the furnace. After about two minutes complete combustion is obtained in the furnace, and then all of the compressed air is pumped directly into the furnace through pipe A, so that within five minutes after starting the furnace a gas containing 6 percent sulphur can be obtained.

Samples of the gas can be taken from the burett pipe, shown in the drawing, so that the furnace can be regulated to give the proper quality of gas desired.

From the above it will be seen that during the operation of the furnace the gas is cooled to about the temperature of the atmosphere, and leaves the furnace cool, dry and under pressure. It is completely under control, so that it can be made of a quality or density to suit a fire-extinguishing or a fumigating case, as may be required. Furthermore, the pumping apparatus is not brought in contact with the gas, since the air is furnished under pressure before passing through the furnace. Therefore there can be no deterioration of the blower on account of contact with sulphur dioxide. Once the apparatus is started, the sulphur is fed through the hopper, so there is no opportunity for the escape of gas fumes. The principal advantages of this machine are that it furnishes almost immediately a positive fire extinguishing gas which will penetrate every part of the hold without damage, as well as furnishing means for freeing a ship of disease germs and vermin. It has been approved by the United States Steamboat Inspection Service, Department of Commerce and Labor, and installations are to be made on the five new large American-Hawaiian steamships now under construction at the Maryland Steel Company, Sparrows Point, Md.

The Rumely Marine Oil Engine

The accompanying line drawing illustrates a 6-cylinder, 9 inch by 12 inch compressed air starting and reversing Rumely marine oil engine, rated at 125 brake-horsepower, the smallest of a line of large heavy-duty marine engines, built principally for mercantile marine service and for large yachts. The fuel used is preferably the ordinary grades of kerosene (paraffin) obtainable at practically all the ports of the world at from three to seven cents (½ to 3½ pence) per gallon. The lower grades of fuel oil, it is claimed, however, have been used very successfully, involving no alteration in engine or carbureters, and incurring no special difficulties. The normal brake-horsepower rating of all the Rumely engines is very conservative, the maximum brake-horsepower output at rated revolutions per minute being in all cases at least 20 percent in excess of the normal brake-horsepower rating, thus insuring utmost reliability of service.

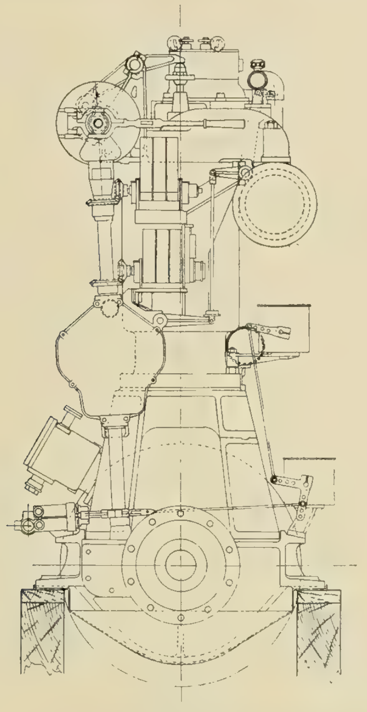


125-HORSEPOWER RUMLEY OIL ENGINE

The engines are designed and built for practically continuous operation at full load under the rigorous conditions

of operation usually found in the mercantile marine field. Correct valve timing, for both the ahead and reverse motions, is assured through the application of two independent and complete sets of cams, all mounted on one cam-shaft, either being shifted into action at will by moving the cam-shaft endwise. Starting, either ahead or reverse, is positively accomplished by admitting highly compressed air to each of the six cylinders in proper rotation, on the explosion strokes only, through mechanically operated valves. This allows each cylinder to draw its proper charge of carburetted air through its respective carbureter and to compress these charges, entirely unaffectd by the action of the compressed air. The compressed air having once set the engine in motion, either ahead or reverse, continues to operate it until the charges drawn in during the suction strokes have become properly carburetted to ignite at the tripping of the spark. The engine then immediately takes up its gas engine cycle automatically, and uses no more compressed air thereafter, even though the operator may still hold the starting valve open. When maneuvering, the engine is claimed to be as positive in its action as any steam engine.

Three carbureters are applied, one to each two cylinders, and no pre-heated air or fuel charges, hot plates, bulbs or tubes are resorted to, nor are any high-pressure fuel pumps or compressed air applied to secure proper atomization of the oil



END VIEW OF RUMLEY OIL ENGINE

charges. The carbureters are designed to thoroughly atomize an exactly proportioned fuel charge and a small quantity of water, at each inspiration, directly into the engine cylinder, together with a thoroughly intermixed air charge which is varied automatically to suit each change of load or speed. The heat of the interior of the engine cylinder, after the engine has been initially started on gasoline (petrol), together with the heat of compression, flashes the minutely divided particles of fuel, each surrounded by air, into a perfectly homogeneous, unstratified explosive mixture, a condition which insures thorough and proper combustion of the fuel and the highest mean effective pressure after explosion. During the beginning (or high pressure and high temperature portion) of the explosion stroke, the atomized water is disassociated into its chemical components (oxygen and hydrogen), the heat absorbed in the process effectively lowering the maximum temperature at the beginning of the stroke, but this heat is regained by the chemical recombination of the water components during combustion, and thus increases the existing cylinder pressures at a point in the crank travel where it can act to greater efficiency in producing turning moment.

Indicator cards show comparatively low maximum explosion pressures, a remarkably full expansion line due to the recombination of the oxygen and hydrogen, which raises the mean effective pressure to 95 pounds, and produces an engine remarkably free from the shocks of explosion, and which is therefore conducive to smooth running. The fuel consumption is claimed to be .9 pint per brake-horsepower hour.

Combustion spaces, cylinders, pistons, valves and igniters, it is claimed, are as free from carbon deposits as in the best gasoline (petrol) engine practice, due to the thorough atomization of the oil charges at all loads, the absence of hot plates, bulbs, tubes, etc., and their attendant oil splitting and stratification of the charges, and to the scouring or scavenging action of the oxygen component of the admitted water. No splash lubrication is applied, all cylinders and bearings being positively lubricated at all times in direct proportion to the engine speed, by means of force-feed mechanical oilers, not more than one bearing being oiled from one feed. Centrifugal ring oilers are applied to all crank-pins.

The crank-shaft, which is of 40-point carbon steel, has seven main bearings. The sub-base is of rigid I beam and channel construction, of cast iron in one piece, and is designed to allow of the removal of any one or more bearing brasses, upper and lower, without disturbing the others. This construction also admits of realining all bearings without removing the crank-shaft, and permits the entire removal of the crank-shaft itself from the engine, within the fore and aft length of the engine, without dismantling the cylinders. The intermediate base is of the open crankcase construction, thus permitting instant inspection of the cranks and bearings merely by pulling aside light sheet-iron covers or splash doors, without the use of tools of any kind.

Cylinders and cylinder heads are cast separately, and any cylinder head may be removed without taking down the cam-shaft. No water is passed through the gaskets, it being by-passed in outside water channels where a possible leak can do no harm and can be fixed at the end of a run. Removal of a cylinder head does not involve the resetting of valves, igniters, etc., when replaced. All the valves are mechanically operated, and the cam-shaft drive is spiral. An inlet suction muffler deadens the hissing of the intake, and is arranged to draw all piston gas leakage from the base into the cylinders and out the exhaust.

Two independent systems of ignition in each cylinder are applied, one a substantial mechanical make-and-break system operating on a low-tension Bosch magneto and a suitable battery for starting, the other a Bosch magnetic make-and-break system. These may be used either independently or in synchronism with the aid of a tachometer.

The rotative speed of the engine, 350 revolutions per minute normally, may be varied throughout a wide range by means of the hand-controlled variable speed governor, which acts on the carbureter throttles. Thus, in a heavy seaway, the speed of the engine remains within a few percent of whatever the conditions may require. All control handles for reversing, compressed air starting, both magnetos, batteries, governor, etc., are grouped conveniently at the after end of the engine and within a 14-inch circle, and no long reaching nor heavy pulling is ever required of the operator.

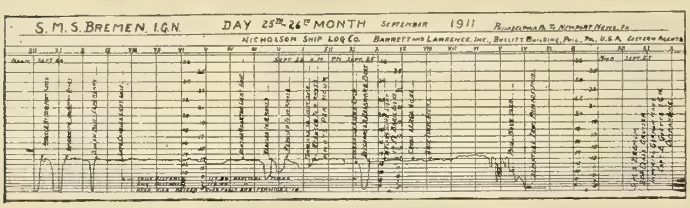
A slip coupling is provided which may be quickly loosened, without allowing the engine and propeller shafts to get out of alinement. This clutch permits easy resetting of the valves; warming up of the engine or operating the engine for any other reason when the craft is tied up to her moorings, or

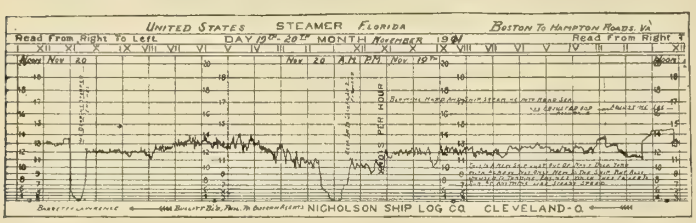
used for auxiliary purposes on a sailing vessel. An air compresser for providing for starting, and other auxiliary purposes is built on the forward end of the engine. This air compresser is automatically cut out of action when the required pressure is reached, and put in again when the pressure drops. A large double-acting phosphor bronze circulating pump geared down to 70 revolutions per minute when the engine is running at 350 revolutions per minute is also built rigidly to the forward end of the engine.

These engines are manufactured by the M. Rumely Company, of La Porte, Indiana.

The Nicholson Ship Log and Automatic Speed Recorder

The ship log manufactured by the Nicholson Ship Log Company, Cleveland, Ohio, has been described in previous issues of INTERNATIONAL MARINE ENGINEERING. The advantages of this instrument lie in the fact that it is located on the bridge or in the chart house where the captain himself can see it, where it not only gives him the distance run but enables him to see at a glance just what effect head winds and rough water have on his ship, while the record card automatically logs graphically any change that may be made for any cause whatever. The device operates by a pressure tube on the bottom of the ship, and therefore requires no trailing line





astern; and is just as accurate and reliable in the confined waters of a river, bay or sound as it is in the open sea.

We are publishing herewith, by courtesy of Barrett & Lawrence, Inc., Philadelphia, Pa., Eastern representatives of the Nicholson Company, two record cards, which we regret we had to reduce very greatly, but we believe the readers of INTERNATIONAL MARINE ENGINEERING will find most interesting; one was made by the German cruiser *Bremen* between Philadelphia and Newport News, Va., and the other by the U. S. S. *Florida* between Boston and Hampton Roads.

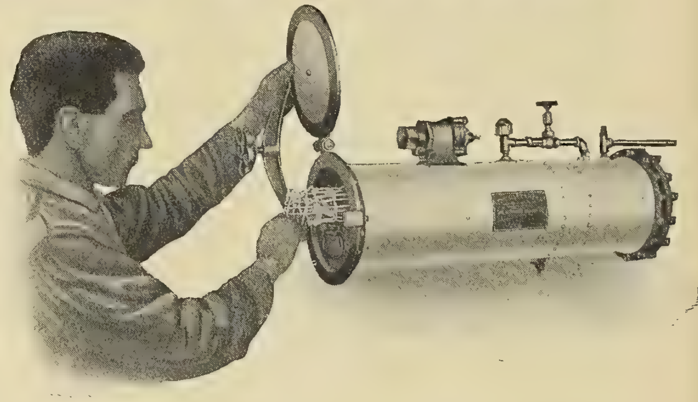
The first named ship is driven by reciprocating engines, and it will be noted how steady her speed is, the only departures being those deliberately made for discharging or taking on pilots, quarantine, or slowing for passing vessels.

The *Florida* is a turbine-driven ship and the crew were not only new to the ship (which was just out of a navy yard) but were as yet unused to turbine engines, which they failed to run at anything like steady speed. It is only fair, however, to say that for the first eighteen hours shown by this *Florida* card the weather was exceptionally heavy, as is borne out by the fact that shortly after midnight she had to be hove to for over an hour to better secure the ship forward.

On the earlier turbine ships in the navy, notably on the *Chester,* where this instrument was first put on board, the speed was very irregular, and the cards were used to steady down the firing, with such success that within a few days they succeeded in producing almost perfect regularity of speed and have been doing so for the whole three and one-half years that they have had the instrument, with a very marked economy in fuel.

Steam Acetylene Generator

The latest device for the production of acetylene gas for marine uses is an acetylene generator which utilizes steam. The steam generator is cylindrical in form, an average size being 10 inches in diameter by 42 inches long, and having a



carbide capacity of 25 pounds. Steam of any pressure is connected to this apparatus, and the gas is made as and when required. In an ordinary water-to-carbide acetylene generator, one drop of water is the smallest quantity which can be fed at one time, but in this form this is attenuated over 1,600 times; the consequence is that the moisture for the dissolution of the carbide is admitted in an almost infinitesimal quantity, and as the steam is instantly converted into gas its generation is practically uniform, regardless of the volume being used. The quantity of steam necessary to operate this generator is so slight as to be practically negligible, carbide as a rule being readily decomposed by the moisture in the ordinary atmosphere.

The steam acetylene generator is made of a welded steel cylinder, galvanized after made, and comprises two chambers, one chamber for the carbide and one to wash and purify the gas. The carbide chamber is divided, one section for the carbide and one into which the residue drops as the gas is made. The residue is not a wet, sluggy matter, as is the case with water-to-carbide or carbide-to-water machines, but is an absolutely dry powder from which all the gas has been extracted. There is very little mechanism in connection with this device, a metal diaphragm allowing the entrance of the steam in such a manner that the internal pressure of the gas controls its own manufacture, this pressure being uniformly maintained at all times after the machine is set in operation.

The steam generator is absolutely safe, as in case of fire there is practically no gas stored within it, neither is there sufficient internal pressure to take serious account of, the average working pressure not exceeding one pound. In case the pressure should rise to a higher point there is a simple water-seal relief which will carry the gas off through a vent pipe into the open air. The generator is also claimed to be absolutely unaffected by heat, vibration or movements of any kind.

Its immediate application to steamships is the lighting of searchlights, signal lights and for interior illumination, and it is obvious that it is particularly valuable for steam tugs and all steam craft, steam-hoisting derricks, shovels, dredges, etc., where a large electric plant is not in use. Its cost of operation is very low in comparison with the cost of other lights. The manufacturers are The Alexander Milburn Company, Baltimore, Md.

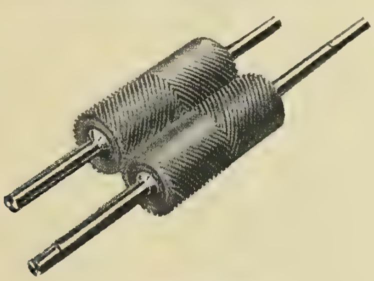
A New Development in Steam Turbines

A strikingly new type of combined impulse and reaction turbine, christened the "Spiro," has been put in the market by the Buffalo Forge Company, Buffalo, N. Y. It is the invention of Mr. John H. Van Deventer, superintendent of this company. The principle of its design and operation is seen at a glance from the two runners with herring-bone teeth. The steam impinges in the central pocket formed by the juncture of the teeth.

The construction of the turbine is extremely simple. It consists essentially of five parts—the case, two heads with bearings, and two rotors. These rotors consist simply of helical gears, cut by special machinery, without any loose or inserted blades. The steam action within the pockets formed by these spiral gear teeth is theoretically perfect, making full use of the impact of the fluid due to its velocity, and avoiding the leakage usually found in turbines, which is the chief cause of their lack of mechanical efficiency.

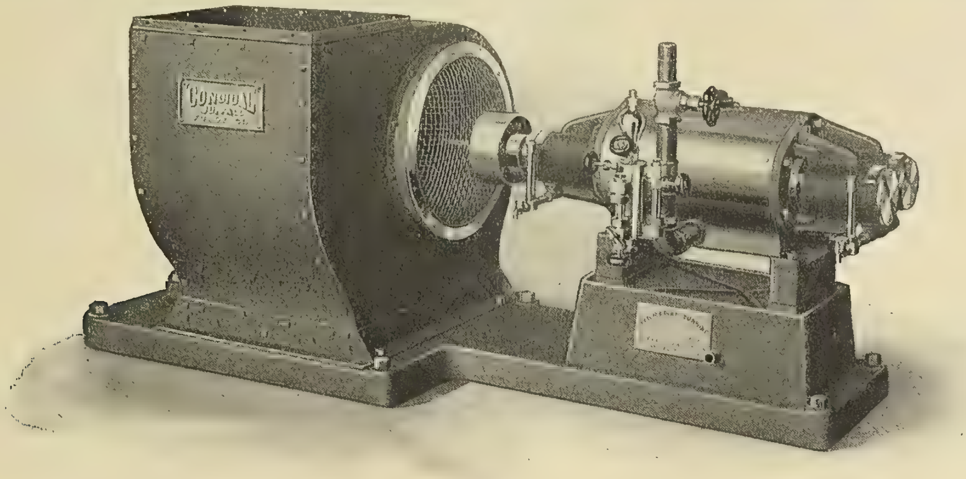
The "Spiro" is at present manufactured in sizes from 1 to 50 horsepower, non-condensing, and patterns are being rapidly completed for an extension of sizes up to 300 horsepower.

There are but two points of wear in the "Spiro" turbine, namely, the bearings, and the tooth contact. In the bearings the lubricating system is so designed that each bearing acts as an individual oil pump, circulating oil through the bearing between shaft and bushing, with a positive pressure. This forms a perfect oil film, and as long as there is any oil in the reservoirs, or oil chambers which form part of each bearing, this oil film is automatically maintained. Thus there is absolutely no metal-to-metal contact in the bearings, all the contact coming upon the oil film.



SPIRO RUNNERS

The tooth contact is said to be very satisfactory. The helical gears are the most perfect known for high-speed service, smoothly running and of strength far beyond the requirements. The length of the spiral rotors in the "Spiro" is much greater than would be necessary for the face of spiral gears transmitting equal loads at equal speeds, and as a result the maximum tooth pressure per square inch is limited to 5 pounds, while ten times that amount would be conservative for long-wearing power transmitting gears. It has also been discovered that a film or cushion of steam is at all times maintained between the teeth of the rotors, which causes an elastic contact sufficient to produce great smoothness of action.



25-INCH "CONOIDAL" FAN DRIVEN BY A 10-HORSEPOWER SPIRO TURBINE

The economy of this type of turbine has been found from tests to be as good as that for reciprocating engines of corresponding size, which, coupled with the fact that the power is obtained from a machine occupying a small space and of light weight, makes it of particular value for driving marine auxiliaries.

Personal

KINGSLEY GOULD MARTIN has become associated with Ray D. Lillibridge, Inc., 192 Broadway, New York, as engineer and writer. Mr. Martin has also been elected treasurer of this corporation.

PROF. HAROLD A. EVERETT, of the Massachusetts Institute of Technology, Boston, Mass., has been appointed by the Eastern Yacht Club Regatta Committee as official measurer for all the yacht clubs in Boston Bay.

ALBERT H. ZIEGLER, who for six years was chief draftsman and designing engineer of the Standard Motor Construction Company, Jersey City, N. J., is now designing and consulting marine engineer for the M. Rumely Company, La Porte, Ind., a concern which is just beginning the manufacture of large internal-combustion engines for mercantile marine service. While with the Standard Motor Construction Company last spring, Mr. Ziegler designed two 300-horsepower lightweight racing engines for a 40-foot hydroplane now building at the Electric Launch Works, Bayonne, N. J., as a defender for the coming Harmsworth Trophy Race. These engines are now on the test stand, and will probably figure prominently in the forthcoming racing season.

Obituary

Walter A. Post, president of the Newport News Shipbuilding & Dry Dock Company, and of the Old Dominion Land Company, Newport News, Va., died suddenly on Feb. 12, aged 55 years. Eleven months ago Mr. Post succeeded the late Calvin B. Orcutt as president of the Newport News Shipbuilding & Dry Dock Company, of which he was formerly general

manager. Mr. Post was born in Kingston, N. Y., and in 1880 he went to Newport News to take charge of the construction of the Chesapeake & Ohio Railroad terminals. Ten years later, as civil engineer, he superintended the erection and equipment of the Newport News Shipbuilding plant for the late C. P. Huntington. The death of Mr. Post is a distressing calamity, not only to shipbuilding interests but to general business interests. Few could have more friends than he had. In the business world his place can hardly be filled, because of his rare personality, which commanded universal admiration, and, what was very exceptional, the affection held for him by those who have spent the best years of their lives working with and under him.

Francis H. Stillman, president of the Watson-Stillman Company, New York, and a prominent figure in machine tool and engineering industries, died suddenly, Feb. 18, in Brooklyn. Mr. Stillman, who was 62 years old, was a Yale graduate. On leaving college he was first associated with the Cottrell Printing Press Company, then with his stepfather, Mr. Lyons. In 1883 he organized and became president of the firm of Watson-Stillman, which succeeded Lyons & Company. The firm was incorporated in 1904 as the Watson-Stillman Company, Mr. Stillman remaining its president up to the time of his death. He was a member of the Hanover Club of Brooklyn, the Engineers' Club of New York, the American Society of Mechanical Engineers, and treasurer of the National Association of Manufacturers. He organized and was first president of the Machinery Club of New York, and was also first president of the National Metal Trades Association. In addition to being president of the Watson-Stillman Company at the time of his death, he was also president of the Bridgeport Motor Company and of the Pequannock Commercial Company, and a director in other manufacturing firms. Mr. Stillman's affable disposition, high standard of business integrity and kind personal interest in all those with whom he came in contact won for him a large circle of friends that will keenly regret their loss in his death.

Technical Publication

Verbal Notes and Sketches for Marine Engineers. Seventh Edition. By J. W. Sothern. Size, 6 by 9 inches. Pages, 631. Illustrations, 515. Glasgow, 1911: James Munro & Company. Price, 10/6 net; $5.00.

This volume is the seventh edition of a book containing notes and sketches of verbal and elementary questions given at the Board of Trade examinations to engineers competing for first-class and second-class certificates of competency. In this edition the original work has been practically rewritten and re-illustrated, several hundred new and original sketches being included. The work includes sections devoted to workshop practice, boilers, notes and sketches of various details, slide valves, piston valves, valve data, general notes and descriptions, marine engineering chemistry notes, marine electric lighting, propellers, refrigeration and internal-combustion engines. The section devoted to boilers has received particular attention, practical examples of the applications of the rules of design, etc., being explained and worked out. The section treating with workshop practice is new and contains material which is difficult to find in any other publication. As has been true in previous editions of this work the practical side of marine engineering has received chief attention.

A chart, 14 by 28 inches, showing a longitudinal view of the interior of a modern submarine boat has been published by the Norman W. Henley Publishing Company, 132 Nassau street, New York. Every detail is shown accurately to scale and 200 parts are numbered and named in an accompanying reference list. The price is 25 cents.

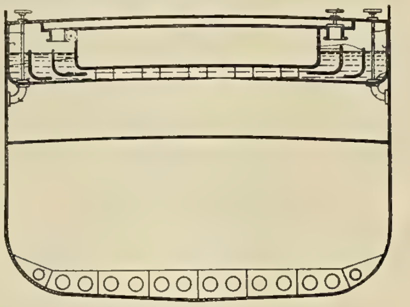
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,007,348. MEANS FOR DAMPING THE ROLLING MOTION OF SHIPS. HERMANN FRAHM, OF HAMBURG, GERMANY.

Claim 2.—In a ship having a U-shaped water chamber arranged transversely thereof and comprising side tanks connected together by a water conduit, said water chamber being adapted to damp the rolling motions of the ship; means for preventing impacts and disturbation of the water



in the water chamber during the rolling motion of the ship an for effecting a uniform rise of the water in the side tanks, comprising bent guide-plates adapted to divide the water flowing from the water conduit into the side tanks into a plurality of streams and said bent guide-plates directing the water upwardly in the side tanks. Four claims.

1,008,532. PRIME MOVER FOR MARINE PROPULSION. CHARLES G. CURTIS, OF NEW YORK, N. Y., AND RALPH L. LOVELL, OF QUINCY, MASS.

Claim 1.—In a prime mover for marine propulsion, the combination of a reciprocating steam engine and a steam turbine, directly coupled to the same shaft, receiving the steam in succession and adapted to utilize the complete expansion of the steam. Thirteen claims.

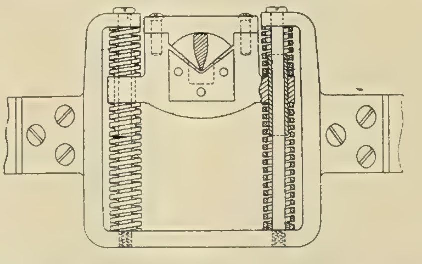
1,008,726. FLUID-PRESSURE POWER PLANT. LUTHER D. LOVEKIN, OF OVERBROOK, PA., ASSIGNOR TO GERARD DEVELOPMENT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—In combination, a rotary expansion engine comprising a casing, a rotary piston therein cleared from the casing, a multi-stage turbine separate and distinct from the rotary expansion engine, said engine and turbine being mounted on separate shafts disconnected from each other, and means whereby the steam driving the piston of the rotary expansion engine and passing the cleared portions thereof is exhausted into the turbine. Two claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C. London.

29,414. SUSPENSION FOR MARINERS' COMPASSES. KELVIN AND JAMES WHITE, LTD., AND F. W. CLARK, GLASGOW.

According to this invention, the knife edges of the compass bowl are made of non-magnetic hard steel or other specially hard metal and co-



operate with V-jewels such as ruby or agate stone, the knife edges and jewels being slightly curved. The jewel block is encased in a sliding piece connected to shock absorbing springs.

27,728. MEANS FOR CLEARING SCALE FROM MARINE CONDENSER TUBES. T. G. BARRON, STOCKTON-ON-TEES.

In this invention rollers mounted in pairs are employed, one pair, for instance, in the vertical plane mounted in angle irons and another pair in the horizontal plane mounted on standards. Each roller has a groove such that when the device is at work the passage between a pair of grooves is elongated or varied from the true circle. By gearing the vertical pair together their synchronous rotation, the requisite grip on the tube and its consequent passage under treatment is provided for. By these means the tube is compressed in one direction to crack and dislocate the scale and then passed through the other pair of rollers, which compress it in another direction for the same purpose.

International Marine Engineering

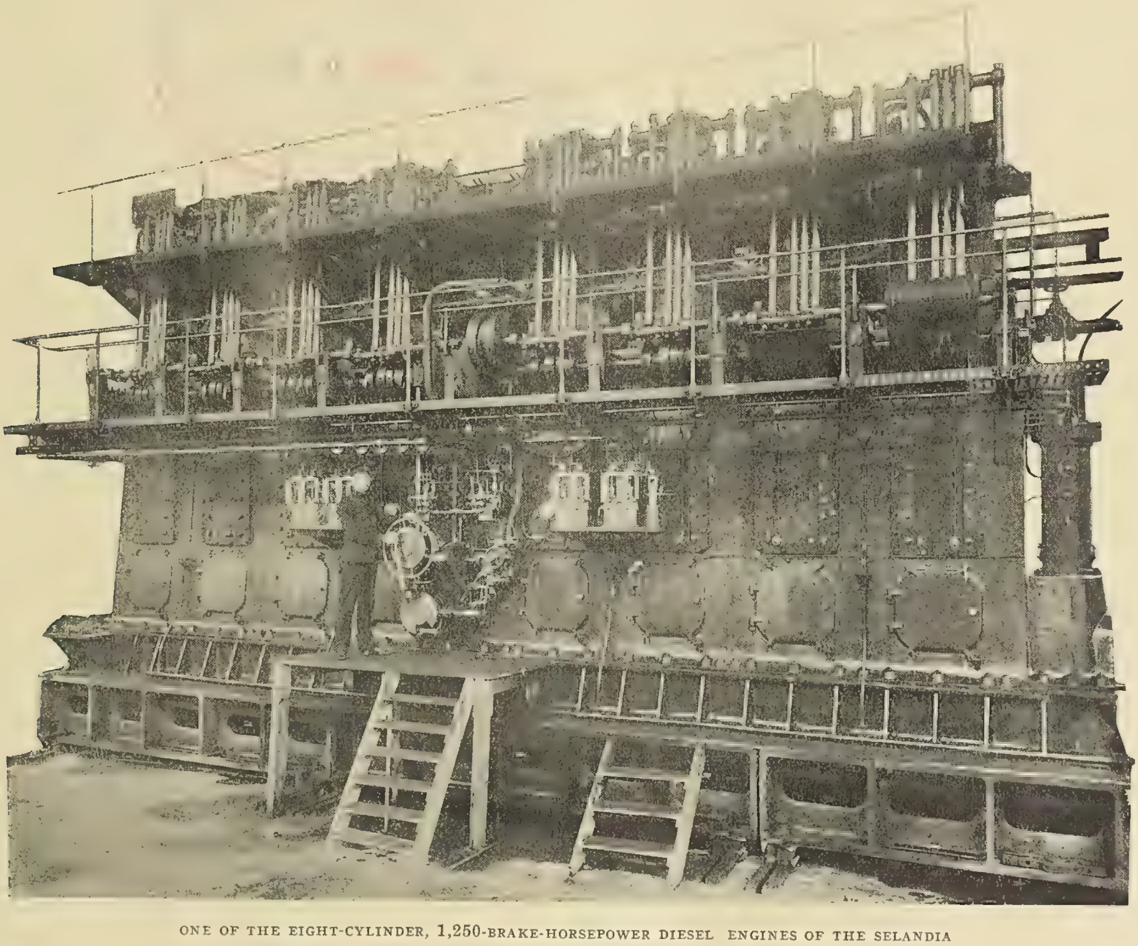
APRIL, 1912

Success of the First Large Diesel Motor-Driven Liner

BY J. RENDELL WILSON

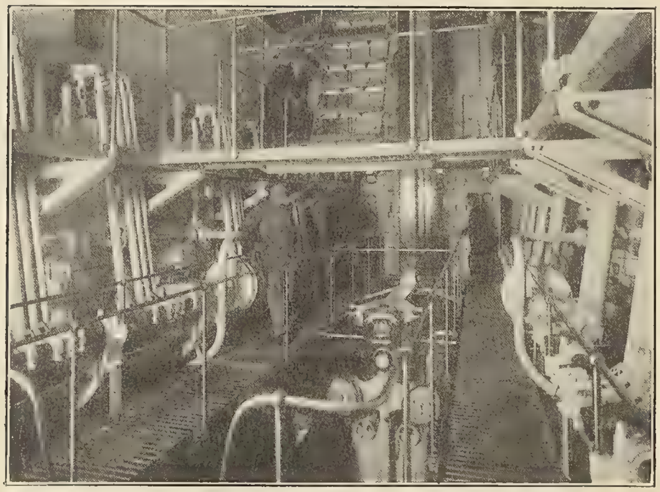
With the trials of *Selandia* (see INTERNATIONAL MARINE ENGINEERING, March, 1912) the future of the big motor ship is practically assured; in fact, immediately following the official acceptance tests, Burmeister & Wain, Copenhagen, her builders, were, I understand, inundated with orders for similar vessels from steamship owners who were aboard, and now have enough marine oil engine contracts on hand to keep them busy for about three years. Credit is due to Burmeister & Wain, not only for having successfully built the largest full-powered Diesel ship afloat, but for having constructed the machinery, which aggregates 2,500 brake-horsepower (3,000 indicated horsepower), apart from two auxiliary engines each of 200 brake-horsepower, in a remarkably short time. How great a stride has been made may be judged from the fact that the largest of the Russian motor vessels, the *Karl Hagelin,* has engines installed aggregating only 1,200 horsepower.

Selandia's trials were carried out at Copenhagen under adverse conditions, having to run through ice, yet a speed of 13.35 knots was attained when running light, although with 950 tons of fuel and fresh water on board. Her loaded designed speed is 11 knots. She is one of the three combined liner and cargo sister ships for the East Asiatic Company, of Copenhagen, having accommodation for fourteen passengers, and will be used for service between Europe and Siam. *Fionia* and *Jutlandia* are her two sisters, and by the time these lines appear in print will doubtless have passed their trials. The first named is also being built and engined by Burmeister & Wain, while *Jutlandia* is being constructed and engined on the Clyde by Messrs. Barclay, Curle & Company, Whiteinch, Glasgow, under license. Bigger motor ships there are, of course, building, but the jump in size and power will have no comparison between that of *Selandia* and existing vessels of her type.

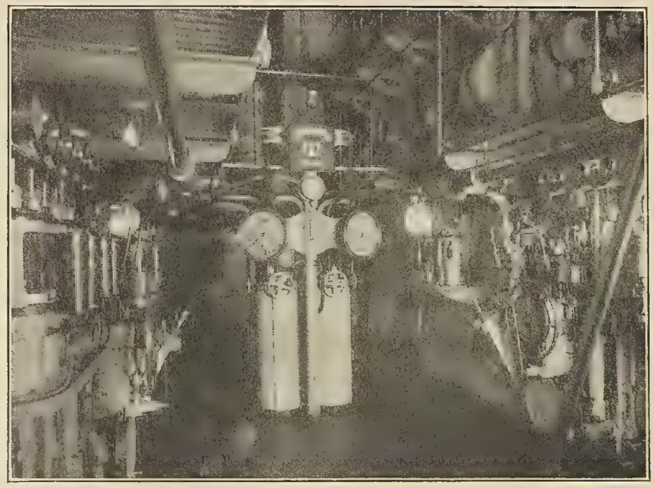


ONE OF THE EIGHT-CYLINDER, 1,250-BRAKE-HORSEPOWER DIESEL ENGINES OF THE SELANDIA

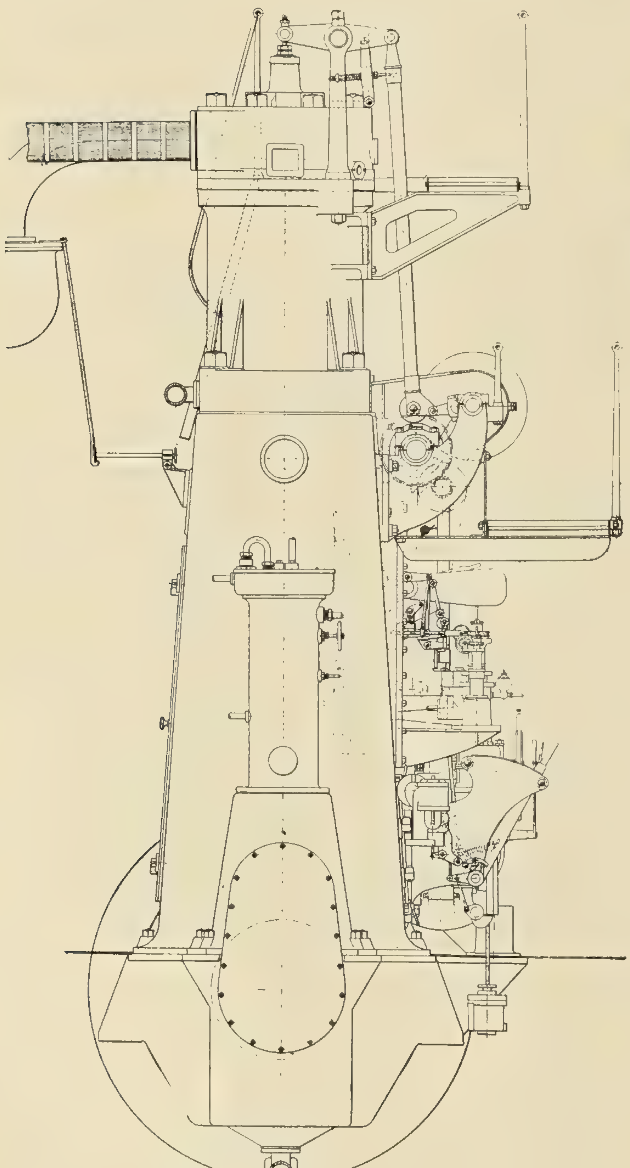
One of the greatest surprises to engineers and steamship



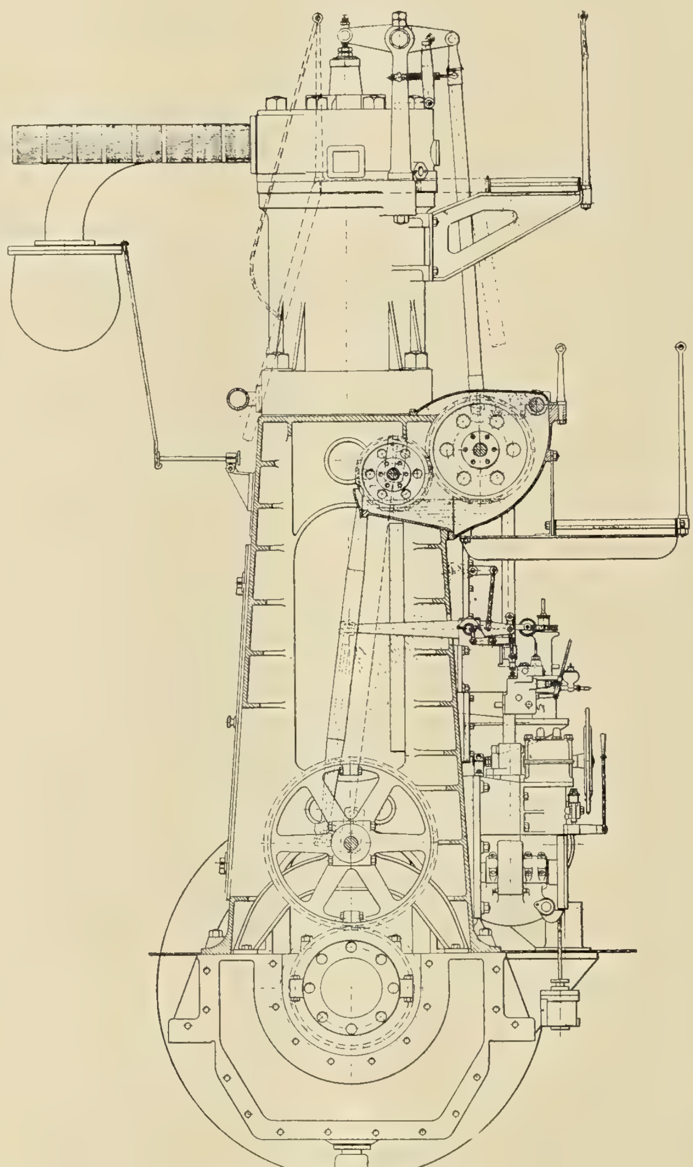
UPPER PLATFORM IN THE ENGINE ROOM



ENGINE ROOM OF SELANDIA, SHOWING CONTROLS

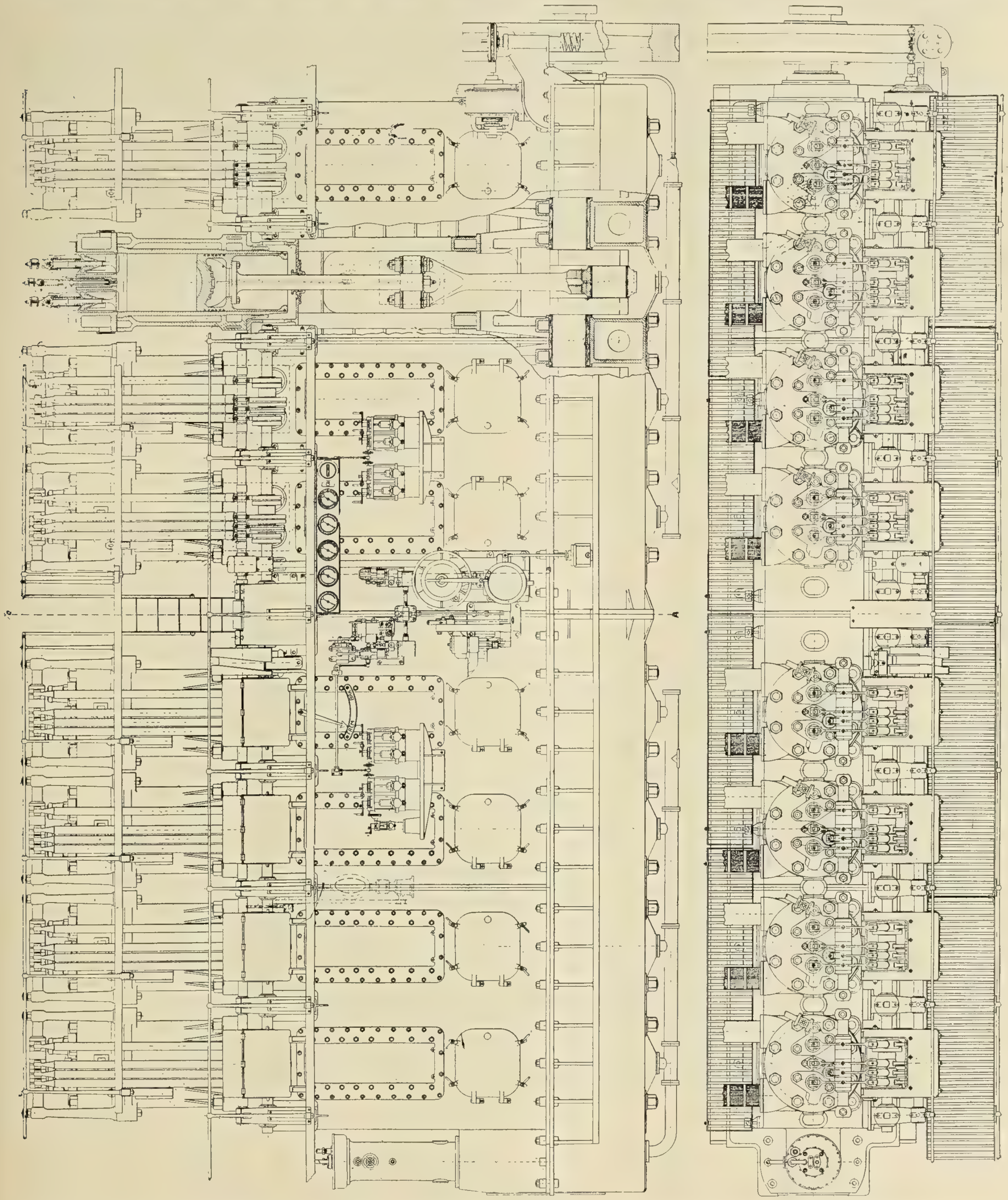


FRONT VIEW OF STARBOARI ENGINE



SECTION OF ENGINE THROUGH A-B

owners present at the trials was that, in addition to the Diesel engines proving perfectly reliable, there was a complete absence of vibration and noise; in fact, it was agreed that her machinery ran more quietly and sweeter than steam engines. When they have been in service for a while, doubtless the running will leave nothing to be desired. Except when starting or reversing the exhaust is quite colorless. On her private trials a week previous she almost collided with the steamer *Skandia,* but was saved through the prompt reversing of her engines. Only 15 to 20 seconds is necessary to change the direction of rotation from "full ahead to full astern." In addition to these three vessels the East Asiatic Company have placed orders with Messrs. Burmeister & Wain for eight more motor ships—two of 10,000 tons and six of 6,000 tons, so the company will soon have a fleet of eleven Diesel vessels aggregating 85,000 tons.

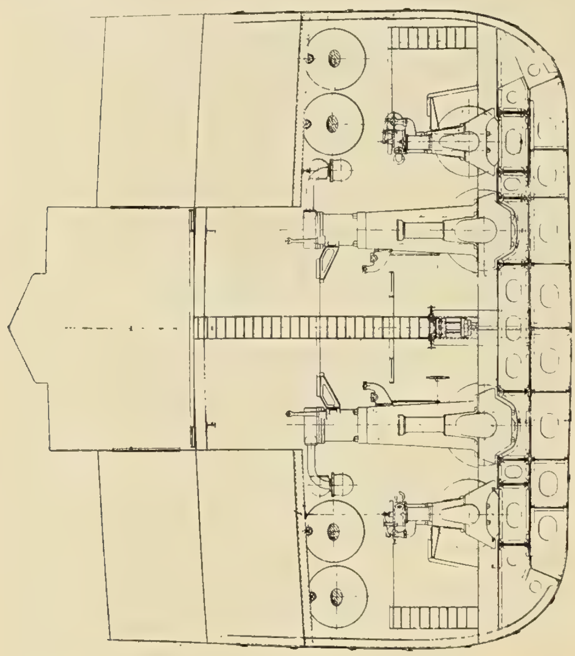


PLAN AND ELEVATION OF 1,250-HORSEPOWER ENGINE FOR THE SELANDIA

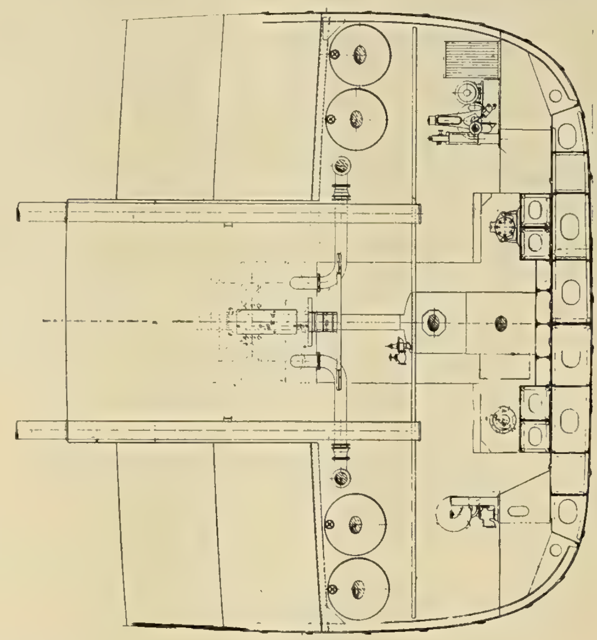
Selandia is 386 feet in length over all, 370 feet between perpendiculars by 53 feet beam, with a molded depth of 30 feet and 22 feet 6 inches loaded draft. Her fully loaded displacement is 9,800 tons, and her deadweight capacity 7,400

tons. The gross tonnage is 4,900 and the net register 3,200 tons. A vast amount of space usually given over to bunkers is saved and given over to the cargo. In fact, her double bottom forms the main fuel tank, and has a capacity of 900 tons of oil, which is sufficient to keep her main engines going for a voyage of 20,000 miles under average conditions. Let us imagine the amount of coal that a steamer of the same deadweight capacity (7,400 tons) would require for a similar cruise. At least 4,500 tons would be necessary, and probably even more.

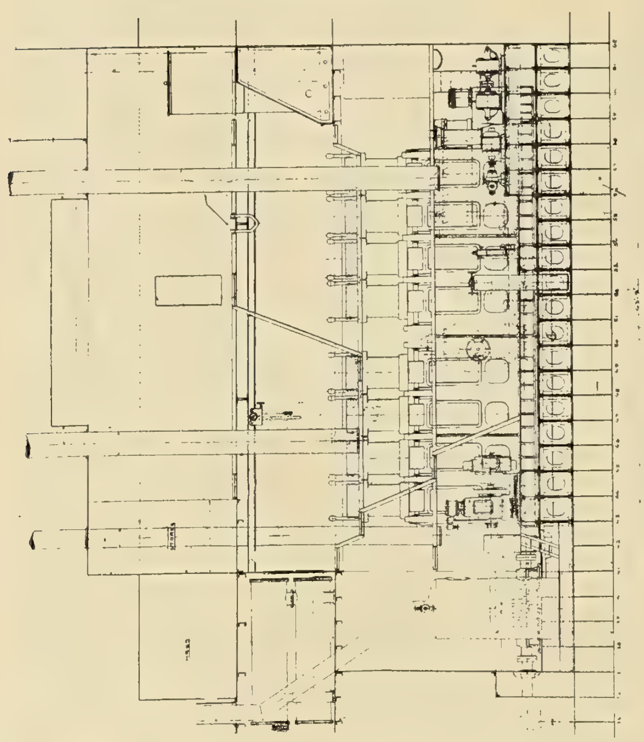
She is a twin-screw vessel, and her main propelling plant consists of two eight-cylinder Burmeister & Wain Diesel engines, each developing 1,250 brake-horsepower (1,500 indicated horsepower) at 140 revolutions per minute; but on the test-bed no difficulty was found in obtaining an additional 150 brake-horsepower at slightly higher revolutions. Of the four-cycle, single-acting type, each cylinder has a bore and stroke of 20⅞ inches and 28¾ inches, respectively. With both engines the cylinders are divided into groups of four, the mechanism for controlling and operating the valve gear being between each group. Each set of four cylinders has the cranks set at 180 degrees, and as the two halves are arranged at 90 degrees to each other, perfect running is obtained, which accounts for the absolute lack of vibration. Another feature towards smooth running is the fitting of four-bladed propellers. The cylinders are mounted on a heavy casing, and are bolted through to very massive engine beds. There are four valves to each cylinder, namely, the air-starting valve, the inlet valve, fuel injection valve and the exhaust valve. All are operated off one main cam-shaft on the front of the engine by means of vertical rods, that in turn actuate the rocker arms on the cylinder head, the rocking movement of

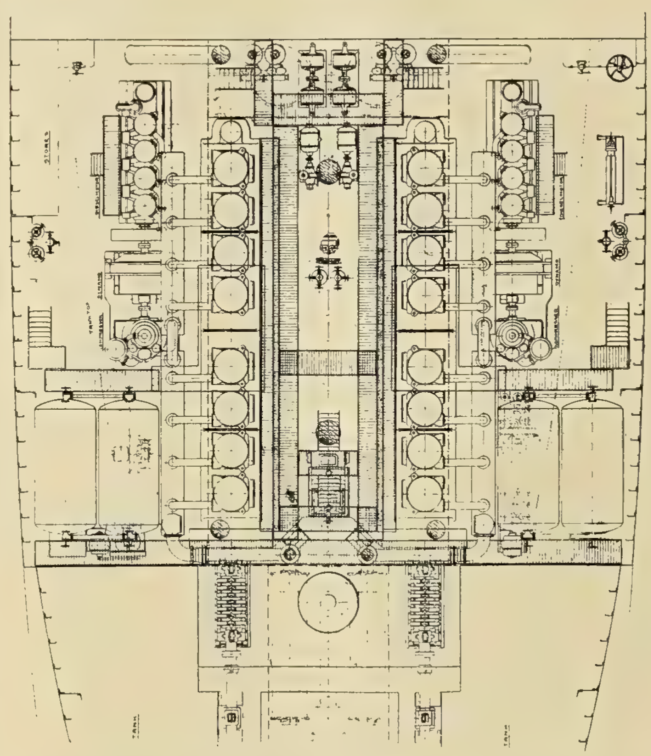


SECTION THROUGH FRAME 51, LOOKING AFT



SECTION THROUGH FRAME 43, LOOKING AFT





MACHINERY SPACE

DINING SALOON

DRAWING ROOM

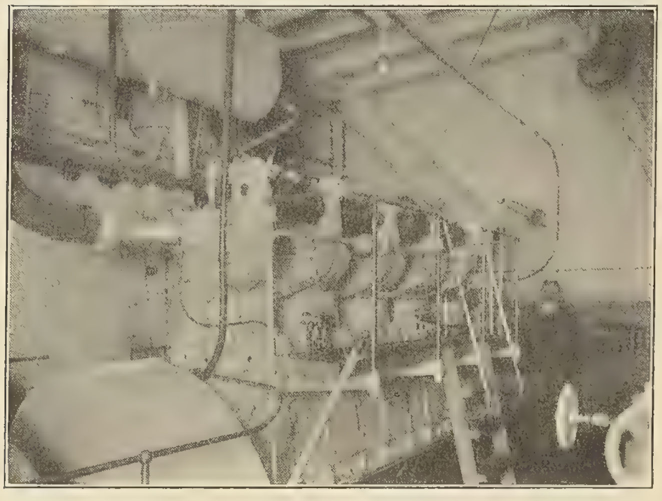
the latter opening and closing the valves, as the case may be. Just over the main cam-shaft, and running parallel with it, there is a lay-shaft, which lifts the vertical valve-operating rods clear of the cam-shaft for starting or reversing the engine. How the lay-shaft lifts the valve rods may be made clear in a few words: The lower end of each rod is boot-shaped, the heel carrying the tappet roller, while the toe is connected to a short connecting rod from a crank on the lay-shaft, and so by turning the lay-shaft a half circle the valve rod rollers are lifted clear of the cams, thus throwing all the valves temporarily out of action. The cam-shaft can then easily be moved into the ahead or astern position. To operate the lay-shaft there is a very small two-cylinder compressed air engine, which is controlled by a single lever. Should, however, this little engine fail, the lay-shaft can be operated by the large hand-wheel shown in the illustration. The lay-shaft also slides the cam-shaft fore and aft for the reverse and ahead positions. Sliding the cam-shaft brings another set of cams into action. In the center of the lay-shaft can be seen a drum, in the periphery of which is cut a diagonal slot, while in the latter runs a disk secured to the cam-shaft. Thus as the lay-shaft is given the half-turn, so the cam-shaft slides on its bearings.

There is only one single-stage compressor actually forming part of each engine, and this is driven off the forward end of the crankshaft, the three-stage compressors being driven by two auxiliary engines of 200 brake-horsepower. The compressor of each main engine takes the air at 300 pounds per square inch, and compresses the same to 900 pounds per square inch, then supplying it to storage bottles. This air is used for fuel injection. For each set of four cylinders there is a separate fuel pump, which delivers the fuel to a distributing box or valve, mounted on the back of each set of cylinders, thence the oil passes to the injection valve of each cylinder. The fuel distributers all have hand regulators, so that the fuel supply can easily be controlled, while there is a hand-pump for priming the fuel pipes when starting. Should the propellers suddenly lift from the water racing is prevented by an

MOTOR SHIP SELANDIA

Aspinall's governor, which shuts off the fuel supply if the engine exceeds 140 revolutions per minute, allowing, of course, the fuel to again come into operation immediately the engine speed drops to normal.

Regarding the auxiliary machinery, there are two four-cylinder Diesel engines of 200 brake-horsepower apiece, each of which drives a 220-volt dynamo, and a three-stage compressor. Under ordinary conditions only one auxiliary set is kept running, the other being a duplicate, and for use when in harbor to supply the necessary current for operating eight electrical deck winches. The three-stage compressor of each set delivers air at 300 pounds per square inch to two large storage bottles, which contain enough air to start the main engines about fifteen times. These 200-horsepower auxiliary sets are quite self-contained, and have their own two-stage



ONE OF SELANDIA'S 200-BRAKE-HORSEPOWER AUXILIARY ENGINES

compressors and storage bottles, so the main compressors (and their storage tanks), which, although driven by the auxiliaries, are not interfered with.

The only steam unit aboard the ship is a three-stage compressor set for use in case of emergency, and even the donkey boiler of this is oil-fired. Air from this set is delivered at 900 pounds per square inch. All the other auxiliaries, such as water pumps, are operated by electricity with the exception of the fuel and bilge pumps, which are driven by an air engine. There are no funnels to the ship, but the exhaust is led up through the hollow mizzen mast, the outlet being about 25 feet above the deck. Although *Selandia's* machinery is estimated to have cost some $50,000 (£10,300) more than that of a steam-engined vessel, her owners expect to gain $40,000 (£8,220) per annum. The reason for this is that no less than $25,000 (£5,140) a year will be saved on the fuel bill alone, while compared with a steamship of the same tonnage she can carry 1,000 tons of cargo more. This, it is stated, will mean $15,000 (£3,080) extra freight receipts. The statement that the motor ship *Selandia* means a total saving of $50,000 (£10,300) per annum will doubtless be dubiously received in many quarters, but this figure the East Asiatic Company considers a very reserved one, as it is not based on full cargoes or passenger receipts for every voyage. Their confidence in *Selandia* has, as before stated, led them to placing orders for altogether eleven motor ships aggregating 85,000 tons.

In connection with the successful trials of the *Selandia*, it is interesting to note the thirty-day non-stop test of one cylinder of a similar engine building by Barclay, Curly & Company, Ltd., for one of her sister ships. During this trial the maximum horsepower developed by the single cylinder was 126 at 143 revolutions per minute. The fuel consumption figured out as .45 pound per brake-horsepower.

Performance of the Archer

Equipped with the first marine producer gas installation on the Pacific Coast, the barkentine *Archer*, 900 tons net, is again in service between Puget Sound and San Francisco engaged in freighting lime in barrels from the quarries and kilns of her owners, the Tacoma & Roche Harbor Lime Company, at Roche Harbor, Wash., to the California ports. While the owners of the vessel have as yet made no official statement giving an idea of how the gas plant is working, some figures have been gleaned indicating that the *Archer's* engines are saving the owners much money, not only in the matter of general expense, but also in time.

When operating under sail, the *Archer* required on an average five weeks to make the round trip between the quarries and San Francisco and return, including time of loading and discharging. Frequently the time was considerably lengthened, especially in the winter, when the vessel was delayed by stormy weather; or in the summer, when calms and head winds resulted in protracted passages. However, with the gas engine plant, the barkentine has practically cut her former time in two, thus doubling her value to her owners, as she will be able to make twice the number of voyages as formerly, and in addition is saving nearly $6,000 (£1,230) per year in towage charges.

The distance from Roche Harbor to San Francisco is practically 850 miles, while the distance from Tatoosh Island, where vessels pass out to sea, is approximately 100 miles less. A resumé of the *Archer's* time since she began operating under power will be of interest.

The *Archer* has made the distance to San Francisco in approximately 4 1/3, 3½, 4 and 4½ days, respectively, while northbound she has been approximately 5 1/3, 6½ and 4 1/3 days en route. Naturally her time has varied with the condition of the weather, but her average will compare favorably with the slower steam tramps operating on this coast. It is considerably less than one-half the time the vessel formerly required when under sail only.

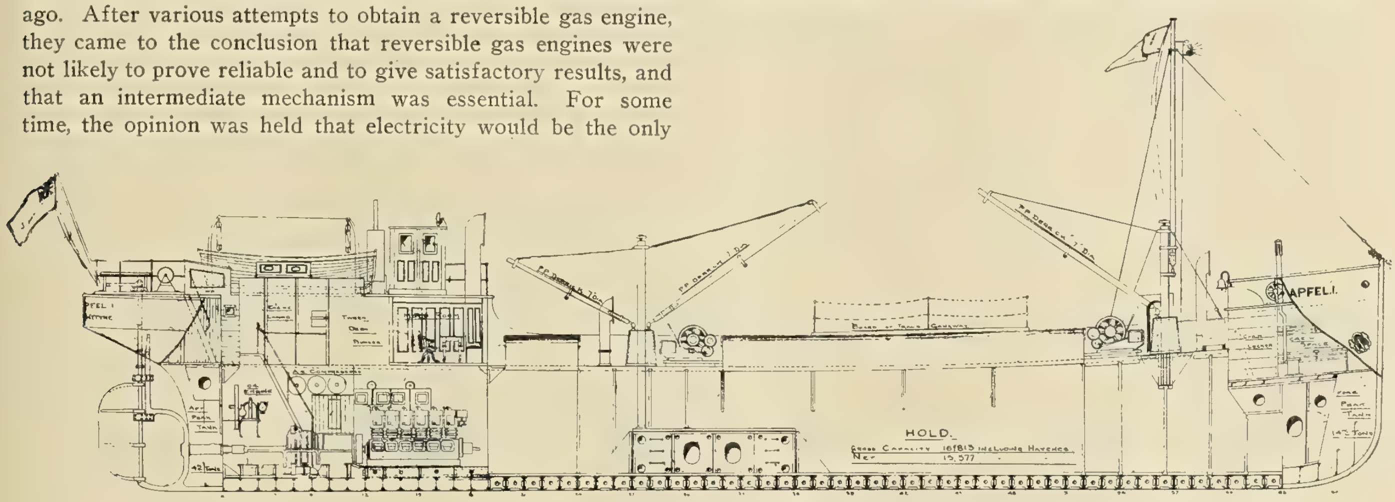
As an illustration of the workings of the producer gas engine in this installation, the data of the voyage leaving San Francisco for Roche Harbor, Nov. 1, is of interest. This was the vessel's slowest run northbound under power, it requiring 152 hours from San Francisco to Roche Harbor, or from 2 P. M., Nov. 1, to 10 P. M., Nov. 7. During this run the *Archer* encountered some severe weather. On this passage the engine was operated 148 hours, during which 425 hoppers of coal were used, each hopper containing 175 pounds. The engine's average was 180 revolutions per minute. With coal at $2 (8s.) per ton, the cost for the passage was but $74.35 (£15.3). The figures show a consumption of 1.67 pounds of fuel per horsepower hour. With the 300-horsepower engine operating at 180 revolutions per minute, the approximate cost was $.502 (2s.) per hour. This is considered a very fair showing and is highly pleasing to the company which made the installation.

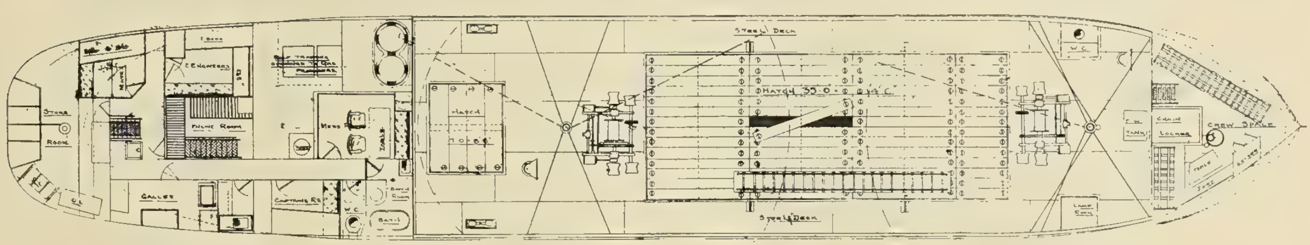
The installation was described in detail in the June, 1911, issue of International Marine Engineering. It will be recalled that the vessel is approximately 900 tons, 180 feet in length, 32 feet beam. The main engine is a 300-horsepower Nash engine built by the National Meter Company, New York. It is of the four-cylinder type, with cylinders 18 by 18 inches, operating at a speed of 200 revolutions per minute. The weight of the engine is 8,050 pounds, and a 500-horsepower Akron friction clutch is mounted directly upon the transmission end of the engine shaft, which is connected to the thrust shaft. The propeller, built by L. H. Coolidge, which is described elsewhere in this issue, is 82 inches in diameter by 82 inches pitch. The producer was designed and built by the Schmidt Gas Power Company, and is of 400 horsepower capacity. It is 9 feet in diameter and 10 feet in height.

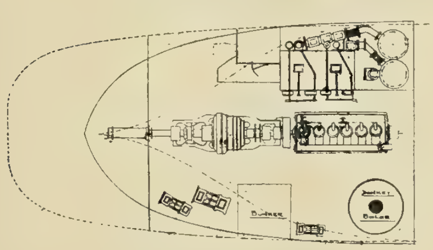
Sea-Going Producer Gas-Driven Cargo Vessel Holzapfel I

BY F. C. COLEMAN

The power gas plant at the works of Holzapfels, Ltd., of Felling-on-Tyne, has worked very satisfactorily for six years, producing gas power at the cost of ¾ pound of bituminous coal per indicated horsepower per hour, and this fact convinced the proprietors of the composition firm of the great economical future of gas power in connection with its adaptation to marine purposes. Accordingly, the Holzapfel Marine Gas Power Syndicate, Ltd., with Messrs. A. C. and M. Holzapfel as directors and Messrs. H. A. B. Cole and T. W. Cherry as consulting engineers, was formed some few months ago. After various attempts to obtain a reversible gas engine, they came to the conclusion that reversible gas engines were not likely to prove reliable and to give satisfactory results, and that an intermediate mechanism was essential. For some time, the opinion was held that electricity would be the only means of attaining this purpose, and accordingly extensive negotiations were conducted with a view to building an experimental vessel and using electricity for reversing, maneuvering and slow speeds. It was not, however, until Professor Föttinger, of Stettin, Germany, perfected his invention of the hydraulic power transformer that Holzapfels realized its suitability for internal combustion engines and secured from the Vulcan Company, of Stettin, the British patent rights so far as gas engines are concerned. Shortly afterwards, a contract was placed with Messrs. J. T. Eltringham & Co., of South Shields, for the construction of a small experimental boat, *Holzapfel I*, which takes rank as the first sea-going gas-driven cargo vessel afloat.







PLANS OF HOLZAPFEL I

Holzapfel I is 120 feet in length, 92 feet beam, 11 feet 6 inches molded depth and has a deadweight carrying capacity of 350 tons. The most interesting feature is the machinery equipment and, therefore, it is not necessary to enter into any detailed description of the hull of the vessel. It will be seen that for the purposes of trim it has been necessary to construct a deep ballast tank amidships and to have two hatches instead of one, as is usual in vessels of this size, and that, in order to conform to existing conditions, the engines and gas plant are placed aft, occupying about the same space as boilers and compound engines of similar class. *Holzapfel I* has been fitted with a set of high speed six-cylinder vertical gas engines manufactured by E. S. Hindley & Sons, of Bourton, Dorset. The cylinders are 10¾-inch diameter, the piston stroke 10 inches and the number of revolutions 460 per minute. The engine is fitted with an equilibrium throttle valve controlled by a crankshaft governor, contained in the extension of the crank-case, similar to that used on the best type of high-speed steam engines. Carbon monoxide gas is supplied from two sets of suction gas producers, and the plant gives 180 brake horsepower as a maximum, the continuous working load being 156 brake horsepower. The engine is fitted with low-tension magneto ignition on Hindley's system, which ensures the correct synchronizing of the revolutions of the armature of the magneto machine in relation to the opening of the spark gap in the cylinder. The actuating gear is of a very simple type. The plugs are operated by vertical rods and six cams and levers similar to the valve motion employed on vertical engines. The magneto machine is driven from the end of the cam shaft and supported on a bracket which oscillates by means of the timing gear around the center of the cam shaft. The combined high and low tension distributor is on the extreme fore end of the cam shaft. Two "Lodge" igniters, one for supplying the current for three of the cylinders, and the other for the remaining three cylinders, are fitted.

All the handles for controlling the engine are situated on

the fore end, so that the engine is easily managed by one attendant. The gas and air regulators are constructed in such a way as to avoid the possibility of sticking in the event of the regulator remaining for long periods in one position. Both these regulators have screw adjustments with an indicator which shows the amount of opening of the regulator, in the same way as a micrometer scale indicates its measurements. There are circulating indicating drums which are marked "Air Regulator" and "Gas Regulator." The readings on these drums show the opening from zero to 100 degrees, so that the ratio from air to gas can be readily seen and the exact position for starting and working under various speeds and conditions can be accurately recorded.

The valve gear is of the ordinary type, now almost universally used in vertical engines—that is to say, the inlet valve operated by rocking lever from the cam and cam lever in the crank-case. The exhaust valve is lifted direct from the cam by means of a roller and lever. There are valve lifters fitted to each exhaust valve by means of which the exhaust valve can be raised on each cylinder apart from the cam so that the engine can be turned round with the greatest ease.

The three fore cylinders are fitted with compressed-air apparatus for starting, and this is also constructed according to Hindley's patented system, and by means of which it is possible to gain access from the compressed-air apparatus to the gas plant. The compressed air is supplied by a separate engine, of quite a small size, and working on petroleum. The compressor is direct coupled to the side of the engine.

The engine has forced lubrication by a valveless pump which is situated at the aft end, in which position there will always be a supply of oil even if the boat is light and she should trim a little by the stern. The cylinders are cooled by sea water supplied by a centrifugal pump driven from the crankshaft by means of bevel gearing which is enclosed in the crank-case, only one end of the shaft projecting through the casing. The pump, which is quite accessible, is of the well-known "Invincible" type, made by Gwynnes, of Hammersmith, London. The spindle, packing gland, and propeller are of bronze. The pump draws the water from the sea-cock and forces it into the circulating manifold on the bottom of the cylinders, from which it circulates through each cylinder and cover separately and then discharges through the ship's side.

The cylinders are of the makers' patented design, which is expanding, but jointless, and extra large water spaces are provided in view of cooling by salt water. In the cylinder of an internal combustion engine, as is well known, water cooling is necessary to keep down the temperature of the wall to the highest point at which no harmful results follow. A water-jacket surrounding the working cylinder is, therefore, a necessity. In vertical gas engines it is an advantage to cast the cylinder and jacket in one piece. To do this in such a manner as to avoid risk of initial strains being set up in the metal due to unequal cooling of the two walls after casting, provision must be made to allow the outer water-jacket wall to expand or contract according to the behavior of the inner wall. This Hindley & Sons have effected by a patented arrangement of corrugation in the water-jacket wall. During the cooling of the casting after founding, should the inner wall contract more slowly than the outer, the corrugations open out, or, vice-versa, they contract.

The exhaust pipe, which is made in seven sections, each of which is water-cooled, greatly facilitates access to the sparking plugs and generally conduces to the comfort of the engine attendants. A small flywheel to the engine at the aft end, which is provided with half-coupling to connect to the Föttinger transformer, and the aft end of the engine frame is constructed with facings for bolting to the framing of the transformer. A small pulley is supplied on the fore end of the engine for driving the auxiliary pumps and a small dynamo and switchboard are provided for charging the batteries for the "Lodge" ignition gear.

The gas plant portion of the equipment of the ship consists of two units each capable of developing 100 horsepower as the normal working load, and comprising two generators and two coke-washers and scrubbers combined. The generator is rectangular in section and plan, with suitable refractory brickwork of similar form with rounded corners, and of such thickness as to prevent undue loss of heat from radiation. An annular jacket is constructed round three sides of the generator, the object being to superheat the air during its passage to the fire, and thus advantageously utilize the heat radiating from the firebrick lining. In the lower portion of the generator is fitted a special triangulated grate with a suitable door at the front of the vessel to admit of ashing and ready withdrawal of the grate whenever necessary. To each side of the center of the grate is fitted an air-tight door for clinkering and ashing purposes. The whole generator can be thoroughly searched from these doors, and the clinkering and ashing operations conducted while the plant is on load. Air supply is admitted to the superheated jacket at the front of the generator and may be regulated by means of a simple horizontal screw-down valve.

For initial starting purposes a small steam jet blower is fitted to the center door; immediately the engine is up to speed this blower is put out of action and the supply of steam for gas-making is then fully maintained from the self-vaporizer fitted to the upper portion of the generator. Each vaporizer consists of four rectangular solid-welded tubes, reaching from back to front of the generator, so arranged that the hot gases pass over their whole surface, thus utilizing a substantial portion of the heat in the gas. The vaporizers are secured to a cast-iron sleeve at the front of the generators and a joint made with sal ammoniac and borings, an absolutely gas-tight joint being thereby effected, notwithstanding the high-pressure of the gas. This arrangement admits of easy removal of any of these tubes in case of inspection or renewals. In the case of *Holzapfel I*, fresh water is used for vaporizing purposes, but the plant can easily be adapted to utilize sea water by means of a simple device patented by Mr. A. C. Holzapfel, the managing director of the Holzapfel Marine Gas Power Syndicate, Ltd.

The brick lining is of substantial thickness, the blocks keying from one to another so that the movements of the ship, however severe, will not disturb the stability of the lining.

The front of each generator forms a part of a gas-tight bulkhead entirely separating the gas producer plant from the engine room, and all the operations in the working of the plant are carried out from the latter room, including stoking, poking and ashing. The stoking device consists of a specially designed hopper and rotary hollow-plug valve, the plug having a port on one side only, so arranged that it is impossible to admit air into the generator during stoking operations. Above the plug is fitted a tapered hopper, communicating directly with the fuel bunkers overhead. For a simple half-turn of this plug, the fuel feeds itself into the generator, having previously fallen into the hopper by gravity from the bunker above. Trimming of the fuel in the bunker or the hopper is, of course, entirely unnecessary. The whole details of the plant have been designed with a view to economy in labor, and absolute safety and assurance in working, in addition to considerations of space occupied, on all of which points it is claimed that substantial advantages have been demonstrated by the operations of *Holzapfel I* as compared with steam practice. On the gas outlet pipe from the generators are provided dust boxes which effectually prevent the choking up of the pipes with dust. As an earnest of the efficiency of this arrangement, it was found that after several months' con-

tinuous use practically no dust remained between the generator, scrubber or pipes. The dust boxes are, of course, periodically cleaned out when the ship is in port.

The coke washer is a cylindrical vessel, built up of steel plates, strongly riveted together. The gas is introduced near the bottom of the vessel, which is filled with suitable sized hard coke, carried upon steel perforated plates; cleaning doors of ample size are provided, these affording facilities for the ready removal and refilling of the coke when repuired, but this latter operation is, however, seldom necessary, and the washers, therefore, require little attention. The upper part of the washer forms a separate compartment containing an adequate depth of wood wool, the function of this part of the cleaning plant being to arrest the moisture and final traces of dust in the gas before passing to the engine. Immediately under the botton plate of this gas-drying chamber a spray pipe distributes sea water over the whole surface of the coke filling, the water being pumped from a gravity-fed sump in the ship's bottom. This has proved a very efficient means of cooling the gas down to atmospheric temperature. The waste water from the washer drains itself through a special arrangement consisting of an inverted cone which restricts the amount of water in motion due to the roll of the ship. A lute is provided and a drain pipe fitted, so that the water inside the scrubber never rises above a certain level and becomes objectionable. The lute lies over and dips into a funnel lead to a waste sump at the bottom of the ship, from which the washer effluent is pumped overboard. The engineer-in-charge has thus visible means of observing that the flow and levels of the water are correct and according to the passing requirements. Centrifugal pumps, belt-driven from the engine, are employed to raise the wash water and to discharge the waste. It is an essential feature of the plant that the water from the coke scrubber should be prevented from escaping into the engine room, and, more important still, the level in the lute pump must be kept at all times within working limits. The bunker, of 12-ton capacity, is situated in the 'tween decks. The hull, engines and gas plant have the highest class at Lloyds.

Since the trials of *Holzapfel I* comparatively little information concerning the ship's movements and performances has been available. This arose from the fact that at the inaugural voyage last summer the vessel met with a collision in the Tyne, and various delays arose from the newness of the machinery on board and from the lack of machinery. Various adjustments of the machinery had also to be made before the vessel yas able to do regular and satisfactory work. The vessel has now carried the following cargoes:

The Tyne to London	242 tons	coke.
London to Llanelly	330 "	scrap iron.
Llanelly to London	330 "	lime.
London to Cork	330 "	hardwood and cement.
Cork to Newhaven	251 "	oats.
Guernsey to London	340 "	granite.
London to the Tyne	340 "	chalk.
Seaham Harbor to Morlaix	331 "	coal, and
Guernsey to Weymouth	330 "	granite.

These voyages were performed in a satisfactory manner and the consumption of fuel is stated to have varied from 25 to 33 hundredweight of coal per 24 hours and, as this is less than one-half the fuel consumption of that of a steam-driven vessel of the same size, and the labor and attendance are also considerably less, there is a considerable economy from these sources. It was found at the beginning that several small improvements could be made in the machinery. Many of these have already been completed and the remainder will now be effected in the Tyne as the vessel is undergoing a general overhaul at the Middle Docks, South Shields. The owners claim that the performances of *Holzapfel I* have already demonstrated its success from every point of view, and careful comparisons made on all points during the whole of these voyages have similarly proved the ability of a gas-driven ship designed on the lines of *Holzapfel I* to compete successfully against any other type of mechanically-driven vessel of her capacity engaged in the coasting trade. The transformers and gas engines have proved a complete success, and the Holzapfel Marine Gas Power Syndicate, Ltd., see no difficulty in fitting vessels of almost any size with complete installations of gas plant, gas engines and hydraulic transformers involving a considerable saving in fuel as compared with steam engines of similar power. The Power Gas Corporation, Ltd., of Stockton-on-Tees, who have done considerable pioneer work in producer gas plants generally, are encouraged by the success of this installation, and have recently prepared designs for equipping vessels of considerable size with gas producer plants to work on practically any class of coal, a distinct advance on the achievements of *Holzapfel* I, where the fuel used in the producer plant is either anthracite or coke, or a mixture of these.

Bureau of Standards Investigation of the Effect of Hydraulic Tests of Boilers

In the matter of research and investigation, where the results are for the good of the community and the safety of the people, the United States is wisely carrying on work which is of the greatest value to the boiler-making world and, of course, consequently to the people at large. Lately the Bureau of Standards Washington, D. C., under the direction of Dr. S. W. Stratton and the direct supervision of Mr. James E. Howard of the Bureau, has been making tests on two boilers built twenty-eight years ago of steel. They must therefore be among the very first made of this material.

The tests are made with a view to seeing the effect of hydraulic pressures on the shell. The utmost care is being taken to do the delicate measuring without possibility of personal error, or of there being any misleading data recorded. The notes will be tabulated and will furnish information never before available. In other words, the Bureau of Standards is doing work which will allow us to eliminate in our equations an unknown or guessed-at quantity, and it seems to us that in so doing public money is being used to its very greatest advantage, as it is being turned from a small local power into a great and widespread knowledge, the value of which cannot be even moderately guessed at. We hope to publish reports of the Bureau a little later. An interesting feature is the instrument which is being used in noting the effect of hydraulic pressure on boilers in straining the shell in a horizontal plane.

Small drilled holes are made in the boiler at given distances apart. These are not large enough to weaken the boiler at all. The strain gage has a fixed point and an adjustable one. The readings of the distances between the drilled holes are first taken when the boiler has no pressure on it; again, when the pressure is put on, the gage is used and a record made of the changes due under the circumstances to the pressure shown. These gaged lengths are located at many places on the boiler, and, consequently, the effects of the weight of the water and the general conduct of the boiler under hydraulic conditions are measured and will be so tabulated as to show just what occurred.

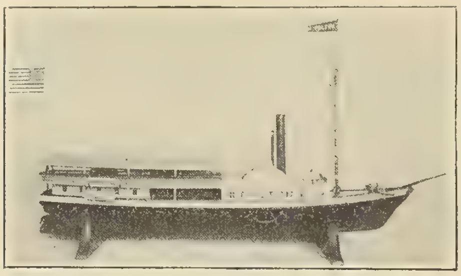
A full account of the above-mentioned tests on two horizontal five-course tubular boilers, given by the Kendall Manufacturing Company, Providence, R. I., is given in a paper entitled "Strain Measurements of Some Steam Boilers Under Hydrostatic Pressures," by Thomas E. Howard, read before the American Society of Mechanical Engineers, New York, December, 1911.

Old American Sound and Coasting Steamers—I

BY FRANCIS B. C. BRADLEE

In this article only a few of the better known and historical old-time Sound and coasting steamers will be described. To go into the subject at length would fill a large volume. As in former articles by this writer the illustrations of vessels and machinery are, in almost every instance, from the collection which the author has been many years making.

The Hudson River and Long Island Sound may not incorrectly be termed the "Nursery of the Steamboat," for there were developed the earliest types of American steam vessels, and there the highest speeds were and still are attained. The first steamboat to ply on Long Island Sound was the *Fulton,* and after her the one that presented most interest was the *Chancellor Livingston.* The former was the last steamer built



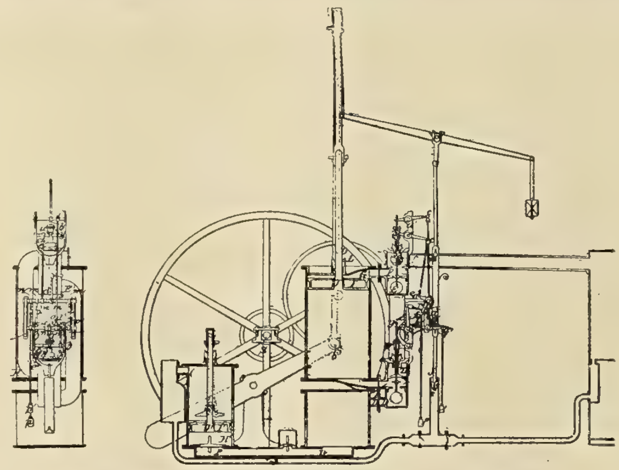
THE PIONEER LONG ISLAND SOUND STEAMBOAT FULTON, BUILT IN 1814
(From a model owned by the N. Y., N. H. & H. R. R. Co.)

under the direct supervision of Mr. Fulton, and the latter was begun just before his death in January, 1815.

The *Fulton* was built (the material being, of course, wood) during the years 1813-14. She was 327 tons gross, 134 feet long and 26 feet beam. She was the first steamboat constructed with a round bottom like a ship, and was sloop-rigged

LONG ISLAND SOUND STEAMBOAT CHANCELLOR LIVINGSTON, BUILT IN 1817
(From a painting in possession of the author)

with a single mast, depending on her sails to increase her speed. The engine was of the "square" or "cross-head" type, built by James P. Allaire at New York, and took steam at both ends of the cylinder (the dimensions of which cannot be found), the stroke being 6 feet. The boiler was 20 feet long by 8 feet high and 9 feet broad, and the fuel used was cordwood. The *Fulton* cost all complete $93,000 (£19,100). It may be here stated that, owing to the burning of the public buildings at Washington by the British in 1814, the drawings and specifications of the early American inventors were all lost, and therefore we possess only very meager information of an authentic character regarding the early steamboats. Being completed before the close of the war of 1812, the *Fulton* plied for a time on the Hudson River between New York and Albany, owing to Long Island Sound being blockaded by the British cruisers. As soon as peace was declared she was placed on the route between New York and New Haven, making the 52 miles that separate these two ports in an



ORIGINAL ENGINE OF THE CHANCELLOR LIVINGSTON (1817)

average of 10 hours and 40 minutes. She burned twenty-five cords of wood on the trip.

The following extract from the New York *Evening Post* of March 25, 1815, concerning the first trip of the *Fulton* between New York and New Haven is interesting:

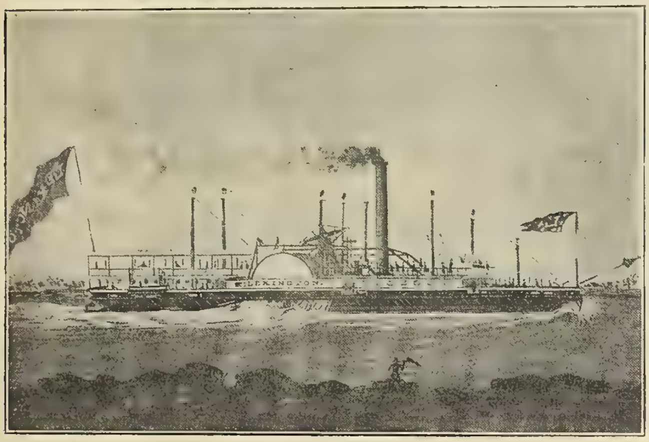
"The steamboat *Fulton* commenced her trip from New York to New Haven on Tuesday last a little after 5 in the morning, and arrived at New Haven at half-past 4 in the afternoon, having completed her passage in a little more than 11 hours. From the performance of the boat at this time it may be concluded that she will not often, if ever again, be so long on her route. The machinery had not been tried since last season and was not in perfect order. Some alterations had been made in the boiler which rendered it also in some measure imperfect, she having been obliged to supply herself with such wood as the New York market offered at the opening of spring. It was of the worst kind, and the least calculated to afford the necessary supply of steam. Yet under all the disadvantages the boat completed the voyage in the time mentioned without any aid from sails.

"The facility with which she passed Hell Gate in both instances surprised everybody on board and satisfied them that no vessel can be so well calculated to navigate this dangerous channel as a steamboat. It has been supposed that the Sound could not with safety be navigated by a steamboat on account of the difficulty in passing Hell Gate, the roughness of the sea and the impossibility of making the compass traverse when attracted by so much iron as must necessarily surround it on board the boat. But these objections the passage of the *Fulton* has proved are without foundation. As to the capacity of the compass, that is tested by the fact that having no land-

marks to steer by, she made Sands' Light according to the course which the needle indicated."

At first the *Fulton* was steered right aft by means of a long tiller, but this method being found clumsy, it was soon replaced by a wheel placed in a pilot house forward. About 1822 the *Fulton* and another steamboat called the *Connecticut* that had been running with her to New Haven, were bought by a company calling themselves the Rhode Island & New York Steamship Company, and placed on the line between Providence and New York, stopping at Newport each way, the fare being $10.00 (£2 1s. 8d.).

The *Chancellor Livingston* was undoubtedly the most complete of Fulton's steamers, although she was finished after his death. She was constructed of oak, locust and cedar, by Henry Eckford, at New York, and no pains were spared to make her the superior of all other boats of her day as regards strength of hull, machinery, etc. She was 496 tons (gross), 157 feet



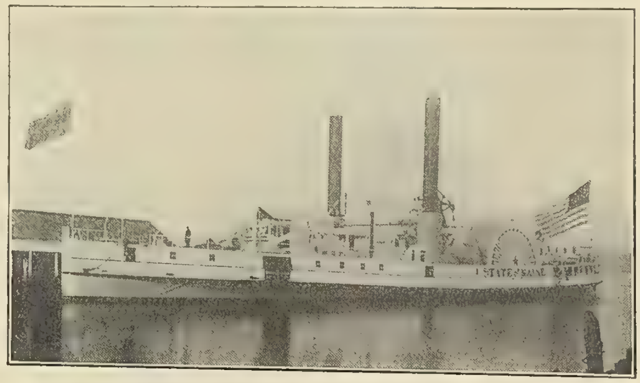
LONG ISLAND SOUND STEAMBOAT LEXINGTON (1835)
(From the original painting, drawn to scale by Jas. Bard in 1838 and now owned by Elisha T. Jenks, of Middleboro, Mass.)

long, 33½ feet beam and 10 feet depth of hold; the machinery being of the "crosshead" type and having one cylinder of 44 inches in diameter, 5 feet stroke, horsepower 65. The engine and boiler, the latter being made of copper, were constructed by James P. Allaire, of New York, and were considered so perfect that for quite a long time all other marine engines built in the United States were more or less copied after them. At first the *Chancellor Livingston* used wood as fuel, but soon began to burn coal, it being found more preferable for keeping up steam. She was the only steamboat in the United States to do this until the early twenties.

The *Livingston* ran between New York and Albany on the Hudson River from 1817 to 1828, when she was given a new boiler and engine (crosshead type) having a 56-inch cylinder by 6 feet stroke, 120 horsepower, and placed on the New York and Providence, Rhode Island line, running against the *Fulton* already mentioned. She continued there until 1832, when she was sold to Cornelius Vanderbilt and others and placed on the Boston-Portland (Maine) route, being the first steamboat to run there, and continued until 1834, when she was broken up at Boston and her engine utilized in a new steamboat called the *Portland*. The *Chancellor Livingston* was certainly not a nautical beauty, resembling more than anything else a Dutch galiot fitted with three smokestacks (she had only two when on the Hudson River service) and paddle wheels.

Before and after the *Chancellor Livingston* other steamboats called the *Benjamin Franklin, Providence, Boston, Washington*, etc., plied on the Sound, but they present no marked peculiarities.

In the early thirties the best known and fastest Sound steamer was the *Lexington*, owned by Cornelius Vanderbilt, and built for him in 1835 by Bishop & Simonson, New York. This steamer had very peculiar lines, being low at the bow and stern, and higher amidships (this can be seen in the picture of her). She was just the reverse from the present style of shipbuilding. The hull of the vessel was heavily built of white oak and cedar, with the frames close together, and she had a very high and short hog frame. The dimensions were



LONG ISLAND SOUND STEAMBOAT STATE OF MAINE, BUILT IN 1848
(From a rare photograph owned by Elisha T. Jenks, of Middleboro, Mass.)

207 feet long by 21 feet beam and 11 feet depth of hold, the paddle wheels were 23 feet in diameter, and she was fitted with a beam engine built by the West Point Foundry, having a cylinder 48 inches in diameter and 11 feet stroke.

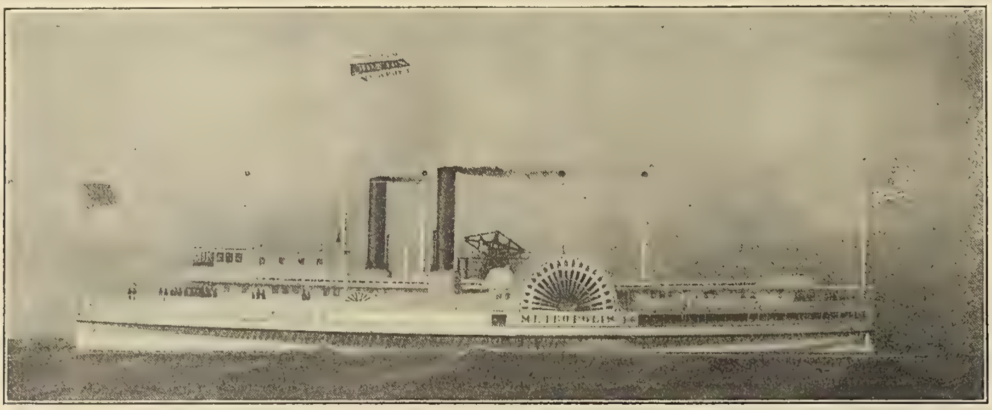
The *Lexington* ran principally between New York and Providence, and sometimes to Stonington or Hartford; her best time was 12 hours and 14 minutes from New York to Providence (180 miles) in June, 1835. She was considered the fastest boat of her day on the Sound, and often had exciting races with an opposition boat called the *John W. Richmond*, belonging to the Atlantic Steamboat Company. In those days the Steamboat Inspection Service was not yet in existence, and great liberties were taken with boiler pressures, etc., so that when races occurred, which were not infrequent events, steamboat traveling in the United States was as risky

LONG ISLAND SOUND SCREW STEAMER PELICAN, OF 1851
(From a lithograph in the author's possession)

as it was exciting. Morrison, in his History of American Steam Navigation, says of the *Lexington*, "that when she was pressed hard, the roar of the fires could be heard all over the boat and at each revolution of the wheels she trembled from stem to stern."

The *Lexington* was the scene of one of the most memorable and at the same time awful disasters that ever occurred on Long Island Sound. On Jan. 13, 1840, while on her way to Stonington from New York, she caught fire when off Eaton's Neck, Long Island. The fire spread so rapidly that the engineer was driven away from the machinery before it could

be stopped, and at the same time the wheel ropes (this was before chains were used) were burned off, so that the *Lexington* drifted down the Sound at full speed, helpless. The weather was bitterly cold, and most of the boats were swamped while lowering, and, to make a long story short, about 140 persons were either drowned, burned or frozen to death. There were only four survivors.



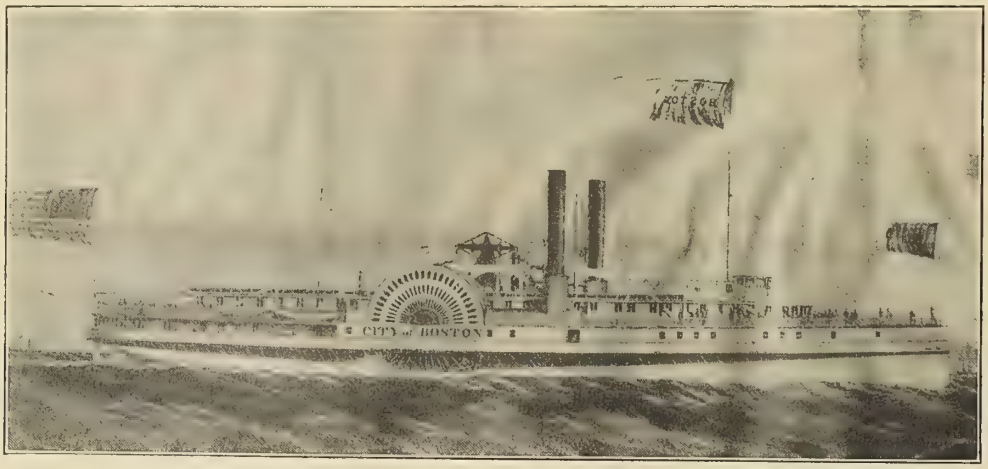
LONG ISLAND SOUND STEAMBOAT METROPOLIS (1854)
(From a painting in possession of the Fall River Line)

Other well-known steamboats at this time were the *Massachusetts* and *Rhode Island,* both built at New York in 1836, and plying on the Providence line. The former was 202 by 30 by 12 feet, with two beam engines and two copper boilers on the guards; the latter measured 211 by 28 by 10 feet, having a "cross-head" engine, cylinder 50 inches in diameter by 11 feet stroke.

The now well-known Fall River line was organized in 1847, under the name of the Bay State Steamboat Company. Until the completion of their new steamer, the *Bay State,* they chartered a screw vessel named the *Eudora*, one of the first ever used on the Sound. She measured 155 by 28 by 9 feet, with what was known as a "simple engine," and during the gold excitement in California was sold for use on that coast. The *Bay State,* when completed, was considered the finest and fastest steamboat in American waters; she was constructed at New York by Samuel Sneedon and measured 317 feet in length, 39 feet beam and 13½ feet depth, tonnage (gross) 1,554; the machinery was built by the Allaire Works at New York and consisted of a beam engine having a cylinder 76 inches in diameter, 12 feet stroke, and making on an average 18 revolutions per minute. There were two iron boilers on the guards carrying steam at a pressure of 25 pounds to the square inch. One great feature also of the *Bay State* was the fact that "she had thirty separate staterooms, which could be had for $1.00 (4s. 2d.) each." This was much commented on in the newspapers of the day.

In point of speed the *Bay Sate* completely outstripped the then crack boats *Oregon* and *C. Vanderbilt,* plying on the Stonington line and ran from New York to Newport on her first trip in May, 1847, in 9 hours 15 minutes. The *Oregon* and *C. Vanderbilt* above referred to were owned by George Law and Cornelius Vanderbilt, respectively, and measured: *Oregon,* 318 by 35 by 10 feet, beam engine, cylinder 72 inches in diameter, 11 feet stroke, and *C. Vanderbilt,* 300 by 35½ by 10½ feet, beam engine, cylinder 72 inches in diameter, 12 feet stroke.

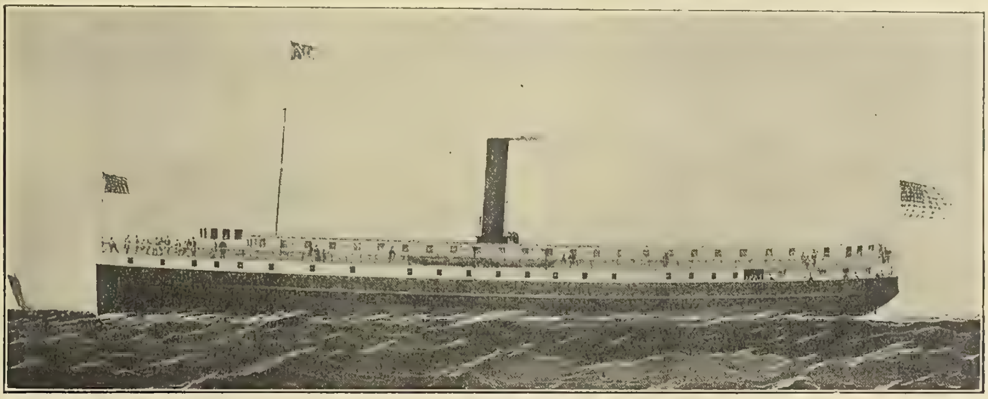
Another steamboat which should be mentioned here was the *Atlantic,* built by Bishop & Simonson, New York, in 1846 for the New London route. She was 320 by 36 by 10 feet, with a beam engine having a 72-inch cylinder by 11 feet stroke. Hunt's *Merchant's Magazine* speaks of her "as being lighted by gas and having watertight bulkheads which would prevent the inrush of water from one part of the hull to another in case of collision, etc." If this statement was correct she was probably the first American steamboat to have watertight bulkheads. The *Atlantic* was lost on Nov. 25, 1846, the primary cause being the breaking of the main steam pipe, which left her helpless in a violent northwest gale so that she drifted ashore on Fishers' Island near New London and about 30 persons were lost.



LONG ISLAND SOUND STEAMBOAT CITY OF BOSTON (1860)
(From an original lithograph in the author's possession)

After the *Bay State,* the Fall River line built in 1848 the *Empire State,* of nearly the same size and dimensions, and in

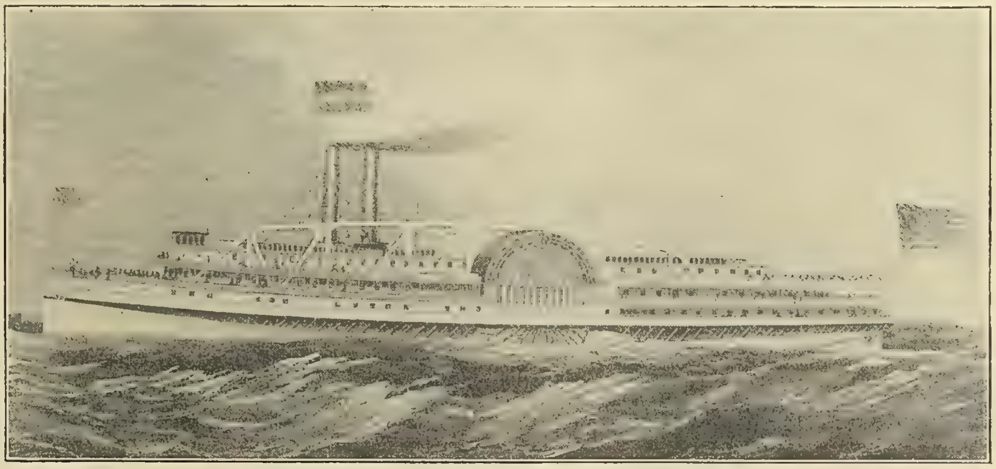
1849 they bought the *State of Maine*, a steamboat that had been built the year before to run between Boston and Bangor (Maine), but proved too large and expensive for that route. She was constructed of wood, at New York, by J. Simonson, and measured 806 tons gross, length 236 feet, beam 31 feet, and depth of hold 11½ feet; the engine was of the vertical beam type, having one cylinder 54 inches in diameter, 11 feet stroke. The picture of the *State of Maine* is from a rare photograph in the possession of Elisha T. Jenks, of Middleborough, Mass., and represents her when she was used as a hospital boat on the James River, Virginia, during the Civil War. She was afterwards sold for use in the West Indies.



THE NEPTUNE STEAMSHIP COMPANY'S SCREW STEAMER ELECTRA

A concern called the Commercial Steamboat Company started in 1851 a line of steamers driven by screw propellers called the *Pelican, Petrel* and *Osprey,* the two latter being 135 by 24 by 8 feet draft. These boats were to run between New York and Providence for freight purposes. They were most curious-looking crafts, as may be seen by the picture of the *Pelican*. The *Pelican* was of 351 gross tons, built of oak at Philadelphia in 1851. The dimensions were 132 by 24 by 9 feet. The engines were of the direct-acting type, having two cylinders, each 28 inches diameter by 28 inches stroke. These must have been among the very earliest direct-acting propeller engines, as most of them at that time were "geared down" to the propeller in one way or another.

By 1854 the traffic had increased to such an extent that another steamer was needed on the Fall River line, and so they had the *Metropolis* constructed by Sneden & Whitlock, at Greenpoint, Long Island. She was very heavily built of wood, the hull timbers being carried to the second deck, strongly braced and iron strapped diagonally, thus doing away with the hog frame, as by this time it began to be recognized that the light Hudson River type of steamboat was not suited to the heavy weather sometimes to be met with on Long Island Sound. The tonnage was 2,210 gross; dimensions, length 325 feet; breadth, 42 feet; depth of hold, 16 feet, there being sleeping accommodations for over 600 passengers. The *Metropolis's* machinery was built by Stillman, Allen and Co., New York, and consisted of a very powerful vertical beam engine having a cylinder 105¼ inches in diameter, 12 feet stroke of piston (the cylinder up to that time was the largest ever cast for a marine engine), there were four iron boilers on the guards, two on either side, set back to back, and having a total heating surface of 12,000 square feet.



LONG ISLAND SOUND STEAMBOAT BRISTOL (1866)
(From an engraving in the author's possession)

The *Metropolis* may be considered one of the most famous steamers ever built in the United States; she was capable of running 20 statute miles per hour, and her fastest trip was from New York to Fall River (181 miles), June 9, 1855, in 8 hours 21 minutes. Eventually she was broken up at Boston in 1879. At this period business was so good on the Sound that it is recorded that in 1850 the Fall River line paid dividends at the rate of 6 percent per month for ten consecutive months.

After the *Metropolis* appeared, a competing line, the Norwich & New London Steamboat Company (which owned the *Plymouth Rock* and other steamers), had built the *Commonwealth* especially to beat her, but although very fast she failed to do so. She was built of wood at Greenpoint, Long Island, by Lawrence & Foulkes, the dimensions being 316 by 42 by 13½ feet. The engine was of the vertical beam type, having one

cylinder 76 inches in diameter, 12 feet stroke. The *Commonwealth* was burned at her dock at Groton, Connecticut, in December, 1865.

After the *Metropolis* and *Commonwealth* no steamboats of especial note appeared on the Sound until 1861, when the New London line had the *City of Boston* and *City of New York,* built of wood, by Sneden & Rowland, at Greenpoint, Long Island. They were 1,591 tons gross each, 300 feet long, 40 feet beam, and 12½ feet depth of hold, the engines were of the vertical beam type built by the Novelty Iron Works, New York, and each having a cylinder 80 inches in diameter, 12 feet stroke, the indicated horsepower being 1,800. These boats were considered among the finest and fastest of their day on the Sound. The *City of Boston,* soon after she was built, succeeded in passing the famous *Metropolis,* and on July 4, 1865, ran from New York to New London (120 miles) in 6 hours and 5 minutes. She and the *City of New York* were broken up at Boston in 1896.

In 1863, the Neptune Steamship Company was organized to run between Providence and New York, and they brought forward the first really large screw steamers on the Sound. These were the *Electra, Galatea* and *Oceanus,* built of wood at New York in 1864, by J. Van Deusen, each steamer being 240 feet long, 40 feet beam and 17 feet depth of hold, having two simple condensing engines with cylinders 44 inches in diameter, 3½ feet stroke. These boats, although intended principally for freight, had accommodations for a limited number of passengers.

During the late sixties, the best known Sound steamboats were the *Newport* and *Old Colony* (1865), of the Fall River line, and the *Bristol* and *Providence* (1867), which were owned at first by the Narragansett Steamship Company, and afterwards by the Fall River line. The *Newport* was built of wood at Greenpoint, Long Island, by John Englis & Son (the *Old Colony* was a good deal like her, only slightly smaller, and had only two stacks in place of the *Newport's* four), measuring 2,150 tons gross, 350 feet long, 43 feet beam and 14 feet depth of hold. Her hog frame was the heaviest ever placed in a steamer up to that time. The engine, built by the Novelty Iron Works, New York, was of the vertical beam type, having a cylinder 85 inches in diameter, 12 feet stroke; there were four iron boilers on the guards, and the paddle wheels were 42 feet in diameter. The *Newport* presented a most peculiar appearance, having four smoke stacks, something that has never been seen before or since on Long Island Sound. She was converted into a coal barge in 1889.

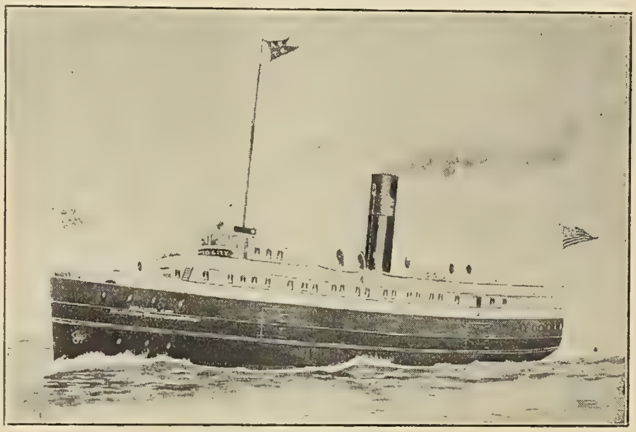
The *Bristol* and *Providence* (sister ships), which followed in 1867, were two of the most celebrated steamboats ever built. Constructed of white oak by William H. Webb, at New York, they were each 2,962 tons gross, 362 feet long, 48 feet beam, 16½ feet depth of hold; the two ships cost $2,500,000 (£514,000), and they were built in the most substantial manner; every beam was bolted fore and aft, and cross-braced with iron from keel to the top of the paddle boxes, in addition to being strengthened by heavy hog frames. There were also numerous watertight bulkheads. Each ship had room for 1,200 passengers, and a great quantity of deck freight. The interior fittings of the *Bristol* and *Providence* were most luxurious, gas lighting, and later on steam-heating and steam-steering gear was installed. Each boat carried a band of music and the officers and crews wore uniforms—two innovations that helped make them famous. Their machinery, built by the Morgan Iron Works, New York, was of the usual vertical beam type, each engine having a cylinder 110 inches in diameter, 12 feet stroke, and making 18 revolutions per minute. Each boat had three iron flue and tubular boilers, carrying a pressure of 18 pounds to the square inch, and the paddle wheels were 38 feet 8 inches in diameter.

These steamers were so fast and popular that the Fall River service was carried on without any further additions until the modern boats *Pilgrim* and *Puritan,* etc., were built. The *Bristol* was accidentally burned at her wharf at Newport, Dec. 30, 1888, and the *Providence* was burned for the metal in her hull on one of the islands in Boston harbor in August, 1901. With these two steamboats ends the "old era" on Long Island Sound, for, with the exception of the *Rhode Island,* built in 1873, for the Stonington line, and followed by the *Massachusetts* in 1877 and the *Connecticut* in 1889 (the latter boat being a grand failure), all the Sound steamboats have been built of iron or steel, and so do not come within the scope of this article.

New Steamer for New York and Atlantic City Route

The Atlantic City Transportation Company has under construction a new steel freight and passenger steamer for its new route between New York and Atlantic City. The hull was completed at the yard of Kyle & Purdy, City Island, N. Y., and launched March 4, and was taken to the yard of the Staten Island Shipbuilding Company, Port Richmond, N. Y., to receive the machinery and joiner work.

The new vessel is of steel construction to the promenade



ATLANTIC CITY BOAT

deck, with wooden house and hurricane deck above. The hull is of the following dimensions:

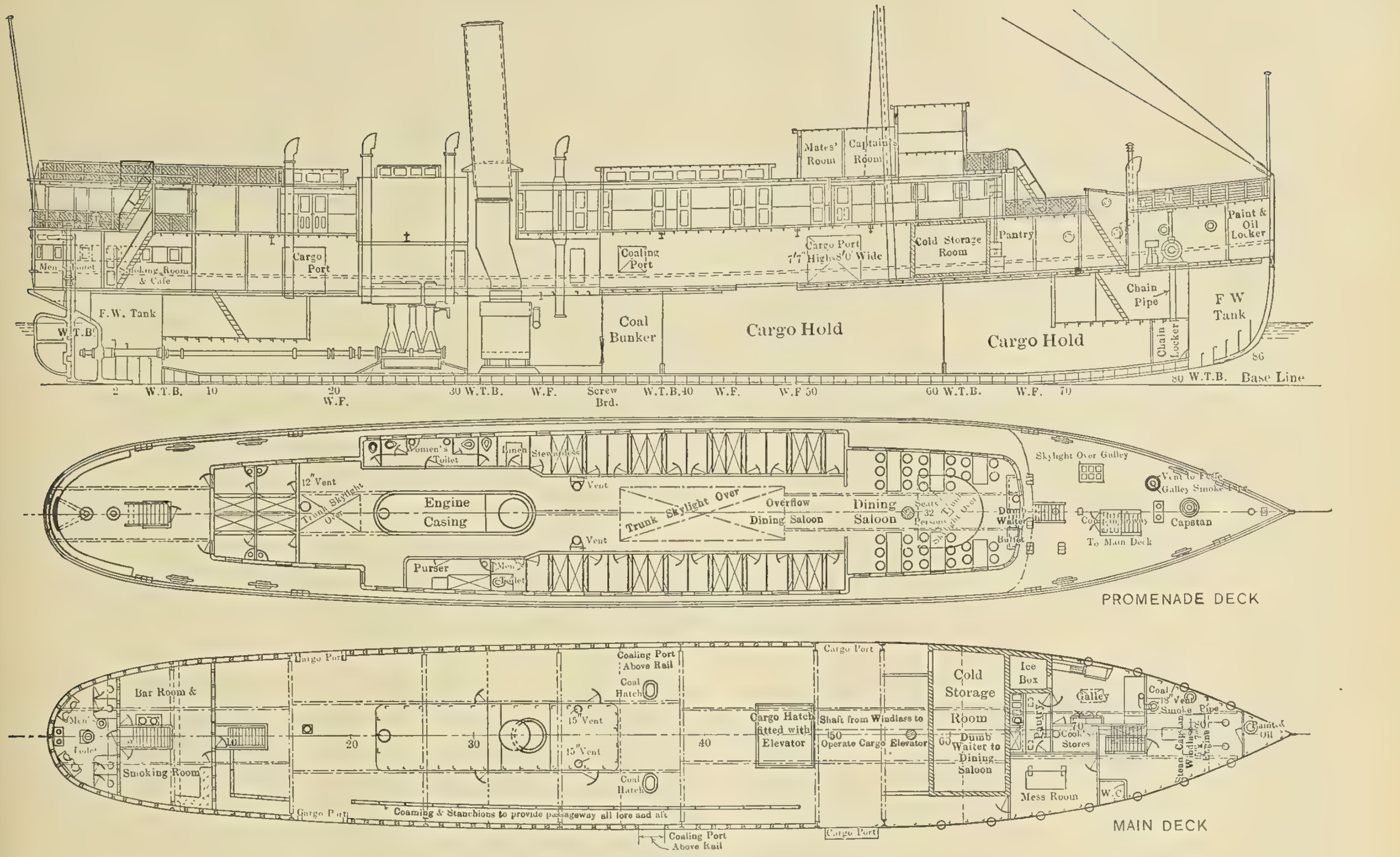
Length on load waterline..........	175 feet 6 inches.
Length over all....................	186 feet.
Molded beam	28 feet 6 inches.
Molded depth to main deck.........	14 feet 6 inches.
Molded depth to upper deck.......	23 feet 4 inches.

The propelling machinery consists of a triple-expansion engine with cylinders 15¼ inches, 23¾ inches, 37½ inches and 26 inches stroke. Steam is furnished by two Almy watertube boilers, with a total grate surface of 95.46 square feet, and a total heating surface of 3,428 square feet. The pumps were furnished by the Warren Steam Pump Company.

The vessel is arranged to suit all conditions met with on this route, and no pains have been spared to secure seaworthiness and the comfort and safety of the passengers and crew. The lifeboat and liferaft equipment will be of the best and of unusually large capacity for a steamer of this description.

The arrangements, as shown on the accompanying plans, provide sleeping accommodations for about 100 first class passengers, and ample freight space on the main deck and in the lower hold.

The Atlantic City Transportation Company has been operating a line of steamers between Atlantic City and Philadelphia for several years, and is adding this new vessel to extend its



PLANS OF NEW ATLANTIC CITY BOAT

traffic to New York City. With a steamer of this description it is expected that the route will become popular with the passenger trade, as the vessel will maintain a speed of nearly 18 miles per hour, which will make the running time a little over six hours.

Atlantic City's commerce by water routes was over 60 percent greater in 1911 than in 1910. The United States government, the State government of New Jersey and the Atlantic City municipal government have appropriated $320,000 (£65,-750), $50,000 (£10,280), $50,000 (£10,280), respectively, for the work to be commenced at once.

The owners' interests in the matter of plans, supervision, etc., have been cared for by Mr. George B. Drake, naval architect, 17 Battery Place, New York. It is expected that the vessel will be in service not later than May 15.

Prize Competition for Designs of a Passenger Canal Boat for the Districr of Teltow, Germany

In November, 1910, the District of Teltow, Germany, invited proposals of designs for a passenger steamer suitable for traffic on the Teltow Canal and the Prinz-Friedrick-Leopold Canal near Berlin. The conditions set forth were as follows:

Length over all	98.5 feet.
Breadth, extreme	18 feet.
Draft, extreme	3.94 feet.
Highest fixed point above waterline	1.3 feet.
Speed, in deep water	8.63 knots.

The seating capacity was to be as large possible. No specific requirements was stated as to the means of propulsion except that they must be arranged in such a manner to avoid damage to the canal bed and sides. The depth of water in the Teltow Canal is 8.2 feet and in the Prinz-Friedrick-Leopold Canal 4.9 feet.

The first and second prizes were $315 (£65) each, and the third prize $100 (£20.5). The prize winners were the following:

First Prize—Mr. R. Blühmke and Mr. F. Peters, Mannheim Schiffswerft.

Second Prize—Mr. F. Mendelsohn and Mr. W. Teubert, Dipl. Ing., Potsdam.

Third Prize—Mr. E. Van der Werf, Blohm & Voss, Hamburg.

Reports which are being received from European countries regarding the appointment of delegates to the Twelfth International Congress of Navigation, which will convene in Philadelphia on May 23, indicate that the attendance will be in excess of expectations, and that the Congress, including the American attendance, will in all probability be the largest ever held. As the time draws near for the opening of this convention a number of the Eastern cities are laying plans to obtain a visit from the distinguished engineers who will come as representatives of foreign countries. These efforts are being seconded by important manufacturing corporations, which realize the value of having so large a number of engineers from abroad visit their works to carry away with them a knowledge of methods and products of this country. Pittsburg, the greatest tonnage producing district in the world, has been quick to see the value that it will be to its interests to be visited by the engineers. It is expected that virtually all of the delegates to the Congress will make the trip to Western Pennsylvania to see the industries of this district. The big corporations in Pittsburg are co-operating with the city authorities to make the visit of the engineers in every way notable. Boston, Buffalo, Cleveland, Detroit and Chicago are among the cities to be visited by parties of the engineers following the Congress.

The United States Turbine-Driven, Naval Collier Neptune

The naval collier *Neptune*, recently finished by the Maryland Steel Company at Sparrow's Point, Md., marks the latest advance in this type of vessel. She is the largest and best appointed collier constructed to date, and embodies many new and novel features. To recapitulate, the general dimensions are as follows:

Length over all	542 feet.
Length on waterline	520 feet.
Beam, molded	65 feet.
Depth, molded to upper deck	39 feet 6 inches.
Forecastle, 8 feet	85 feet.
Poop, 8 feet	171 feet.
Load draft, molded	27 feet 6 inches.
Displacement on load draft	19,440 tons.
Deadweight	13,040 tons.
Block coefficient	.727
'Midship section coefficient	.982

The general design for this collier was developed by the builders in accordance with the requirements of the Navy Department, and, as will be seen from the illustrations, comprises six large holds for coal, the forward one being subdivided into four for the carrying of fuel oil in place of coal when required. There are also four oil compartments below the lower deck forward. Top-side tanks are fitted in way of cargo holds in addition to the usual double-bottom tanks. At the ends of the vessel there are three decks in addition to the poop and forecastle.

FIG. 1.—UNITED STATES COLLIER NEPTUNE

The officers and crew have commodious quarters in the poop, in a house on the poop deck, and on the berth and lower decks below.

The hull is constructed of steel in excess of the requirements of the American Bureau of Shipping. The joiner work is tasteful, generally of white pine, enameled. The officers' rooms are trimmed in oak. All toilets and baths are tiled and fitted with the most modern type of fixtures, the bath rooms being supplied with hot and cold fresh and salt water. The floors in the living quarters are covered with best Navy linoleum. A complete set of engine-room telegraphs, inter-communicating telephones and annunciators is installed.

The principal point of interest in this vessel is, of course, the coaling gear. This was designed and installed by the Maryland Steel Company, the winches being purchased from the Lidgerwood Manufacturing Company, New York. As will be seen the gear consists of a series of structural towers connected together at the center line near the top by a girder, which also serves as a track for a fore-and-aft trolley to transship coal from one hold to another in order to maintain trim when on long voyages, or to replenish the bunkers. All of the towers, except the forward one, are fitted with four booms. The heads of opposite booms are connected by wire rope spans, on which travels a trolley. The trolley is manipulated by means of in-haul and out-haul ropes led over the ends of the booms. The requirements of the Navy Department were that the gear should handle 100 tons per hatch per hour, using a 1⅝-cubic yard clam-shell bucket. This requirement was exceeded on test, no difficulty being experienced in delivering 110 tons per hour. The Maryland Steel Company has applied for patents on this type of coaling gear.

Propelling Machinery

The propelling machinery consists of two 4,000-horsepower Westinghouse marine turbines, running normally at 1,230 revolutions per minute. The turbines drive the propeller shafts through Westinghouse reduction gears at a speed of 135 revolutions per minute. A view of one of the *Neptune's* turbines and its gear assembled for test at the works of the builder is shown in Fig. 3.

The turbines are of the combination impulse and reaction type. Each turbine comprises an "ahead" and an "astern" element on a single rotor in a single casing. Fig. 4 is a view of one of the turbines with the cover removed. The left-hand end with the larger number of rows of reaction blades is the ahead element, and the right-hand end, consisting of one row of impulse blades and only six rows of reaction blades is the astern or backing element. The exhaust connection is at the low-pressure end of the ahead turbine. The rotor being hollow the vacuum reaches back to the astern element, so that the latter does not offer any resistance when the ship is going ahead. When going astern the backing element exhausts through the hollow rotor.

The joint between the upper and lower halves of the casing, instead of being in a horizontal plane as is usual, is inclined at a very decided angle. This feature of the design makes it

possible to connect the steam exhaust pipes to the bottom half of the casing, so that the cover may be swung open on hinges without breaking any important pipe connections, so that the rotor and blading may be exposed for inspection with a minimum expenditure of time and labor.

In marine installations the condenser cannot usually be located below the turbine casing, and the exhaust coming from the bottom of the casing, with an upward sweep to the condenser, acts like the "entrainer" that is considered essential in exhaust pipes leading to barometric condensers, and effectively voids the turbine of water that would otherwise tend to collect in the bottom of the casing.

Fig. 5, from a photograph of one of the *Neptune's* turbines, shows the exhaust connection and the opening in the jacket for the steam connections to the ahead and astern sections. This illustration also shows the hinges on which the cover swings.

The total weight of the two turbines and two reduction gear sets installed in the *Neptune* is only 235,364 pounds. A sister ship, the *Cyclops,* is fitted with reciprocating engines of the same power, which, with their reversing and turning gear, are reported to weigh 586,000 pounds. The use of the high-speed turbines with reduction gears effects a saving of over 350,000 pounds, or almost 60 percent, in the deadweight of the main propelling engines.

Another feature of interest in this installation is the system of pneumatic tele-control, by which the turbines may be started, stopped and reversed and their speed adjusted from the bridge. Fig. 6 shows the bridge operating stand—which is practically a duplicate of the operating stand in the engine room—with its two levers for controlling the turbines independently of each other. The dial gages are connected to pipes running aft to the engine room, and their indications show instantaneously that the desired action has taken place. Of course, this bridge control does not interfere with the turbines being handled in the ordinary way by the engine room force. In case, however, of an accident to the steering gear of a twin-screw ship, its convenience and value would be recognized immediately, and it will perhaps develop that there may be many other conditions in which its desirability will be apparent.

The speed of the turbine is controlled by a centrifugal governor, the action of which is resisted by a piston working in a cylinder against an adjustable air pressure. The speed is varied by altering the air pressure, and with the governor in action at all speeds, racing, or even noticeable variation in the speed, is impossible under any circumstances.

Auxiliary Machinery

There are two independent condensers, each having 5,400 square feet cooling surface. The tubes are ⅝ inch outside diameter, No. 16 B. W. G. thick, and are tinned. Two centrifugal circulating pumps, having 14 inches suction and discharge, driven by 10-inch by 9-inch vertical engines, are installed in connection with condensers. An auxiliary condenser of 1,000 square feet cooling surface, with attached air and circulating piston pumps, is installed for port use.

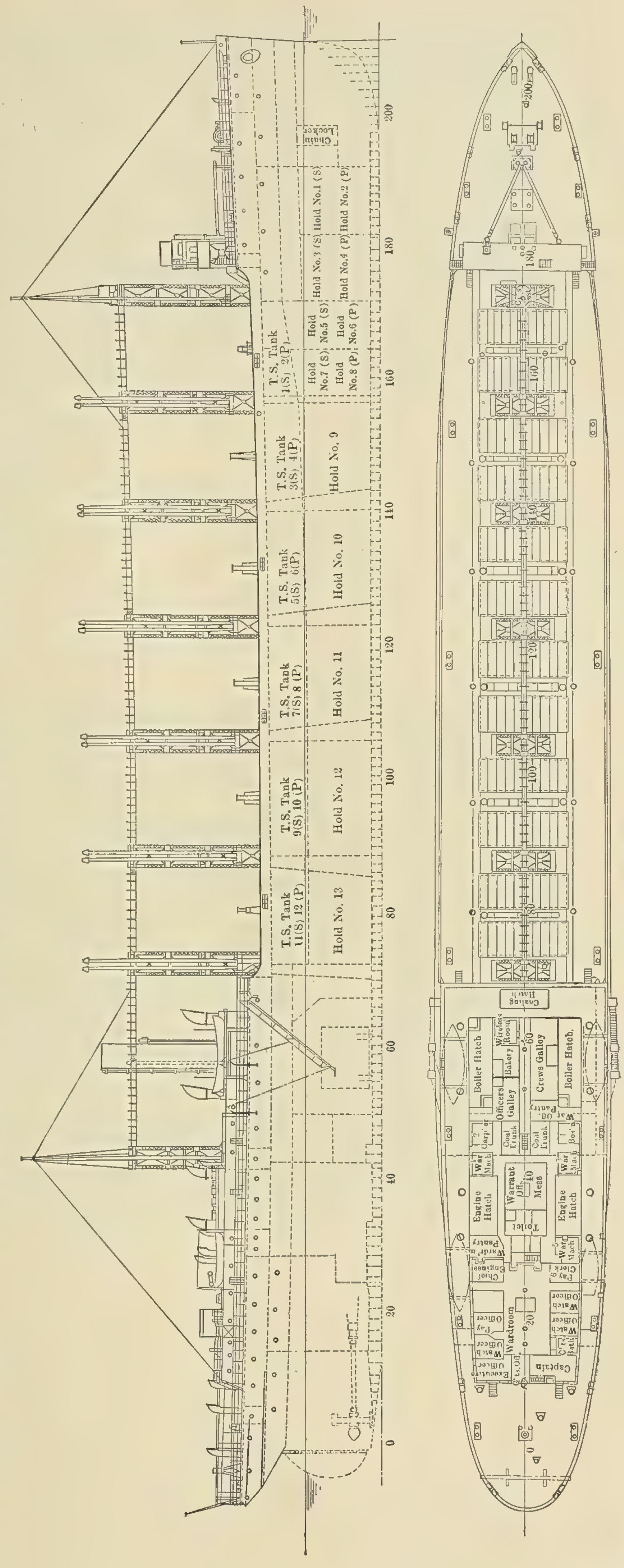


FIG. 2.—DECK PLAN AND PROFILE OF THE NEPTUNE

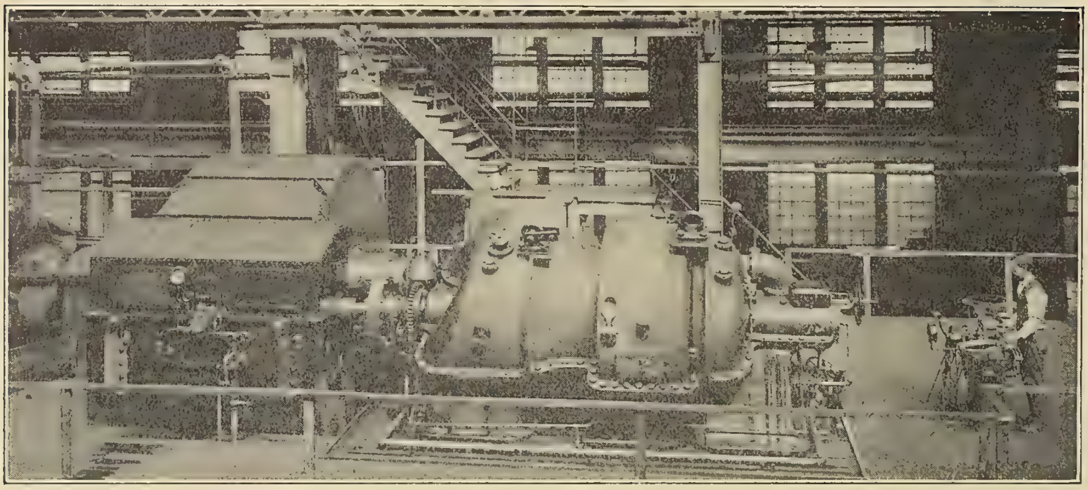


FIG. 3.—ONE OF THE NEPTUNE'S TURBINES WITH REDUCTION GEAR, ERECTED IN THE BUILDER'S SHOPS

There are two main and one auxiliary feed pumps, each of the vertical simplex type, 14 inches by 10 inches by 24 inches. Connection is only made between the fresh water supply and boilers. These pumps discharge through a cartridge type grease extractor and multi-coil feed heater, or can be bypassed direct to boilers. One duplex ballast pump, 12 inches by 14 inches by 12 inches, is provided for pumping out the double-bottom tanks and for pumping up the top-side ballast tanks.

One 5¼-inch by 4¾-inch by 5-inch vertical duplex evaporator feed pump.

One 7-inch by 4-inch by 7-inch horizontal simplex donkey boiler feed pump.

One 12-inch by 14-inch by 18-inch vertical duplex cargo oil pump.

Two evaporators, each of 20 tons capacity per 24 hours, and two distillers, each of 1,500 gallons capacity, are installed, and there is a steam driven, ammonia type refrigerating plant to

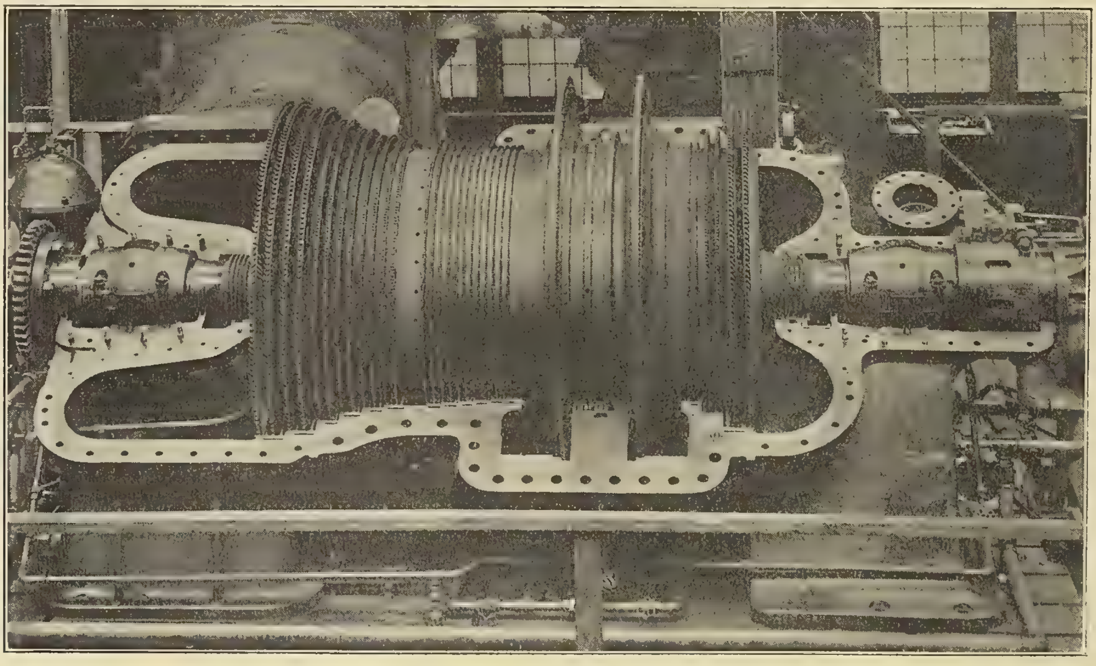


FIG. 4.—TURBINE WITH COVER REMOVED

The following is a list of the small pumps provided and connected up to perform their respective duties:

One 6-inch by 10-inch by 12-inch horizontal simplex bilge pump.

One 10-inch by 7½-inch by 12-inch vertical duplex fire pump.

One 5¼-inch by 4¾-inch by 5-inch vertical duplex fresh water pump.

One 6-inch by 5¾-inch by 6-inch vertical duplex sanitary pump.

One 6-inch by 5¾-inch by 6-inch vertical duplex distiller circulating pump.

cool a room of 2,000 cubic feet volume for ship's stores.

Two 15-kilowatt, 125-volt, direct-connected electric generating sets are installed.

There are three double-end main boilers, built for a working pressure of 200 pounds, each 15 feet 10½ inches mean diameter by 21 feet 4 inches long, with four 40-inch corrugated furnaces in each end, each furnace having a separate combustion chamber. The total heating surface is 18,920 square feet. A hot air forced draft system is installed, the air being furnished by two blowers, each capable of delivering 30,000 cubic feet of air per minute to the furnaces.

There is one donkey boiler, 8 feet diameter by 10 feet 6

inches long, built for 200 pounds working pressure and for natural draft. It is fitted with one 44-inch corrugated furnace, and has 650 square feet heating surface.

The winches on the *Neptune* were furnished by the Lidgerwood Manufacturing Company, of New York. There are two winches for each hatch, the control levers of which are brought to one operator, who stands looking down into the

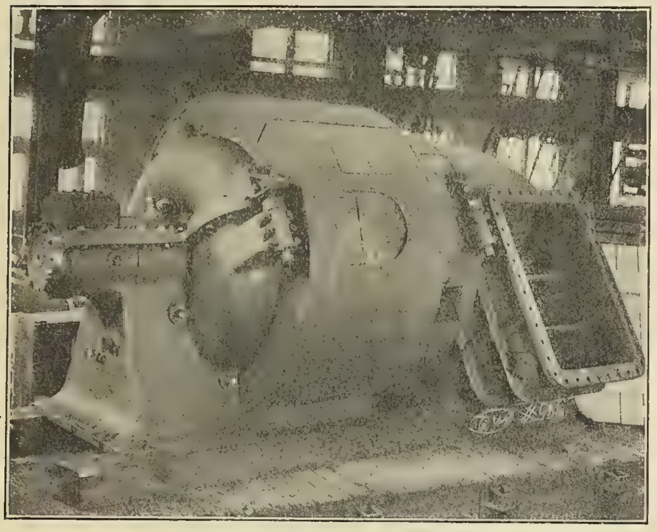


FIG. 5.—VIEW OF TURBINE, SHOWING EXHAUST AND STEAM CONNECTIONS

hatch. These winches are of the Lidgerwood universal type, which are adapted to operate the marine transfer as installed on the *Neptune* or to do any other of the regular work of cargo discharge. They will hoist 3 to 4 tons on a single line with rapidity and certainty, and are under absolute control, both in hoisting and lowering.

When the marine transfer is used one of these winches hoists, opens and closes the bucket, while the other winch swings the bucket from the hatch to the end of the boom. Each winch is controlled by a single operating lever, although a foot brake is brought into the operation on the bucket winch when it is necessary to open and close the bucket. One hun-

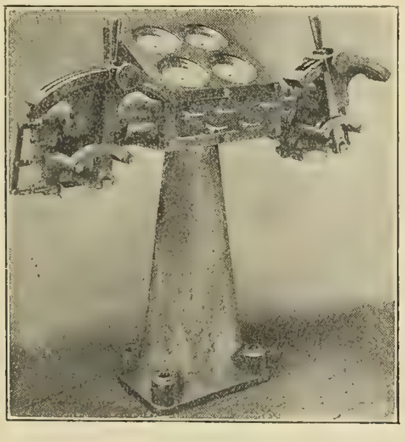


FIG. 6.—BRIDGE OPERATING STAND

dred tons of coal per hour has been discharged by each pair of winches from the hold of the collier to a lighter, ship or dock alongside. The winches are of very sturdy construction. They have 9-inch by 10-inch double cylinders and piston valves. The working pressure is 150 pounds. The gearing is of steel and pinions of bronze, all with machine-cut teeth. The gears and pinions are entirely covered with guards, so that it is practically impossible to catch any foreign substances in the gears, and also permits of very efficient lubrication. This makes a very quiet, smooth running winch and reduces the vibration to a minimum. The life of this gearing is considerably longer than the regular machine molded teeth, and the efficiency is considerably greater.

The frictions are of the Spencer Miller metallic type, which are not affected by water or operating conditions. The brake on the bucket engine is all metallic, thus avoiding all troubles which heretofore have been so common aboard ship. An automatic brake is furnished on the swinging winch, which holds the winch stationary against any load which the winch is capable of hoisting when the steam is shut off by the operating valve. This automatic brake makes the operation simple and safe without any care or attention on the part of the operator.

All sheaves and bearings are bushed either with bronze or babbitt metal, so that in no case does iron or steel come against other iron or steel, which fact insures the operation of these engines no matter for what time they have been out of service. There is nothing exposed to the weather which is not simple, or which has any tendency to corrode or be injured through exposure. The parts of all of the winches are interchangeable, so that in case of any breakdown a similar part from another winch can be used with the certainty that it will fit.

Institution of Naval Architects

The annual meeting of the Institution of Naval Architects for 1912 was held in the hall of the Royal Society of Arts, John street, Adelphi, March 27 to 29. The following papers were read and discussed:

Wednesday, March 27

1. Some Military Principles which Bear on Warship Design. By Admiral Sir Reginald Custance, K. C. B., K. C. M. G., C. V. O.

2. On Turning Circles. By Prof. W. Hovgaard.

3. The Law of Comparison for Surface Friction and Eddy-Making Resistances in Fluids. By T. E. Stanton, D. Sc.

4. Description of the William Froude National Tank (Part II). By G. S. Baker.

Thursday, March 28

5. Results of Trials of the Diesel-Engined Seagoing Vessel *Selandia.* By W. I. Knudson.

6. Gas Power for Ship Propulsion. By A. C. Holzapfel.

7. The Effect of Bilge Keels on the Rolling of Lightships. By George Idle and G. S. Baker.

8. Results of Calculations Regarding the Effect of an Internal Free Fluid Upon the Initial Stability and the Stability at Large Angles in Ships of Various Forms. By A. Cannon.

9. On the Solignac-Grille Boiler and Its Application in French Channel Steamers. By Monsieur G. Hart.

10. Results of Experiments on Watertube Boilers, with Special Reference to Superheating. By Harold E. Yarrow.

Friday, March 29

11. Geared Turbine Channel Steamers *Normannia* and *Hantonia.* By Prof. J. H. Biles, LL. D., D. Sc.

12. Performance on Service of the Channel Steamer *Newhaven.* By Monsieur P. Sigaudy.

13. On the Measurement and Automatic Recording of Dead Reckoning. By F. R. S. Bircham.

14. Description of a Tide Indicator. By Commander G. J. Baugh, R. I. M.

15. The Arrangement of Boat Installations on Modern Ships. By A. Welin.

16. Torsional Vibrations of Elastic Shafts of any Cross Section and Mass Distribution, and Their Application to the Vibration of Ships. By Dr. L. Gumbel.

17. Load Extension Diagrams Obtained Photographically with an Automatic Self-Contained Optical Load-Extension Indicator. By Prof. W. E. Dalby, M. A., B. Sc.

The annual dinner of the Institution was held on Wednesday, March 27, at 7:30 P. M., in the Grand Hall of the Connaught Rooms.

Practical Application of Marine Producer Gas Power Plants

The reduction of cost in the operation and maintenance of the power plant of every type of craft engaged in commercial service is of great importance, and some of the installations which have been made in the past twelve months where producer gas is being employed will undoubtedly show the progress which is being made along these lines. The operation of producers on shipboard under the most trying and varying conditions has demonstrated beyond question their ability to meet the most difficult conditions, and one which accentuates this feature very clearly is that described in the following:

The cultivation, propagation, catching and shipping of oysters is a large and important industry extending from the New England coast into the Gulf of Mexico. Thousands of men are employed in it, and the oyster boats, a very large proportion of which are propelled by gasoline (petrol) engines, comprise a fleet which runs into large figures. In these boats the motor not only propels the vessel but it is geared to hoists which operate the dredges. When the boat reaches the oyster beds the motor is slowed down to about one-quarter to one-third speed, the dredges are thrown overboard and dragged over the beds slowly; after a short interval (the length of time depending on whether the ground is thickly or thinly covered, one dredge is raised by throwing in a friction on the drum hoist, and after the dredge has been pulled in over the rail the friction is thrown out and the oysters are deposited on deck. The dredge is then lowered over the side and the other dredge raised, this alternate raising and lowering of dredges continuing during the day. It will easily be seen that this causes a very uneven load on the motor, the load varying from one-quarter power to full power instantly. After the desired number of bushels have been raised the throttle is opened up and the boat driven at full speed to the discharging station.

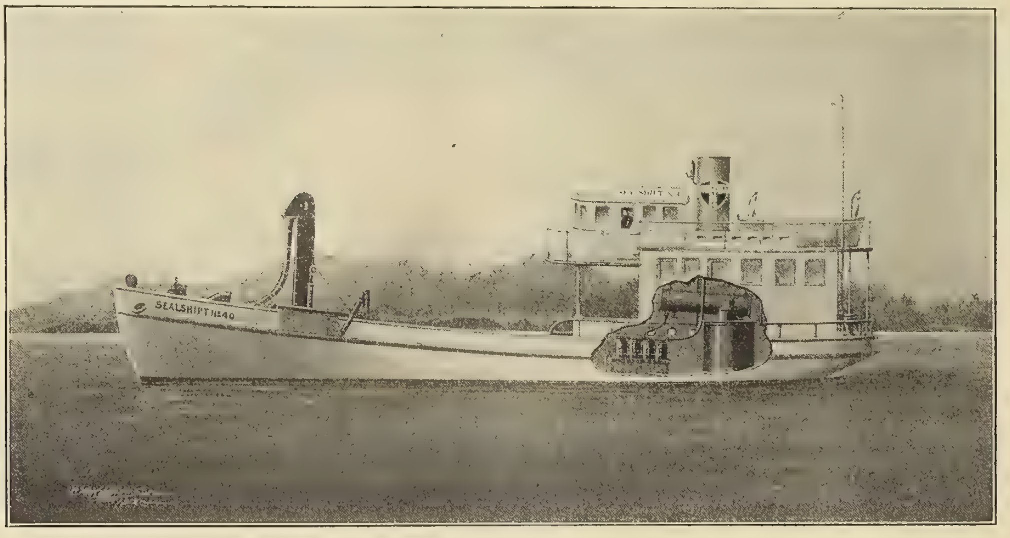


FIG. 1.—PRODUCER GAS OYSTER DREDGE

Fig. 1 shows an oyster dredge, 66 feet long over all, 22 feet beam, 6 feet 3 inches draft, which is being equipped with a 150-horsepower producer-gas plant. The engine will be a four-cylinder, four-cycle reversing engine, 12 inches bore, 18 inches stroke. This boat was formerly propelled by steam, but the economies obtained in smaller boats which have been equipped with producer-gas power indicate that the substitution of producer gas for steam power will reduce the fuel consumption to about one-third that of the old and smaller steam equipment. In addition to this it is found that the carrying capacity of the boat will be increased not less than 50 percent, due to the lighter weight of the producer plant, its greater compactness, and the smaller amount of fuel required to operate the same distance as was formerly done with steam. This holds true of all steam-propelled boats, and is a factor which cannot be overlooked by an owner desiring to obtain the maximum efficiency out of his equipment. Work on a still larger boat of this type is under way, calling for a 250-horsepower plant of the same make and type.

From the above figures, which are not theoretical calculations, but have been proved in actual daily service, the net returns in this field to the owners of this type of boat are sufficient to insure a comfortable income independent of whatever the boat may do as a bread winner as she is powered at the present time.

Coastwise schooners of almost every conceivable size are frequently handicapped by their inability to make port under adverse weather conditions. Their value as cargo carriers would be greatly enhanced if their time of arrival at, and

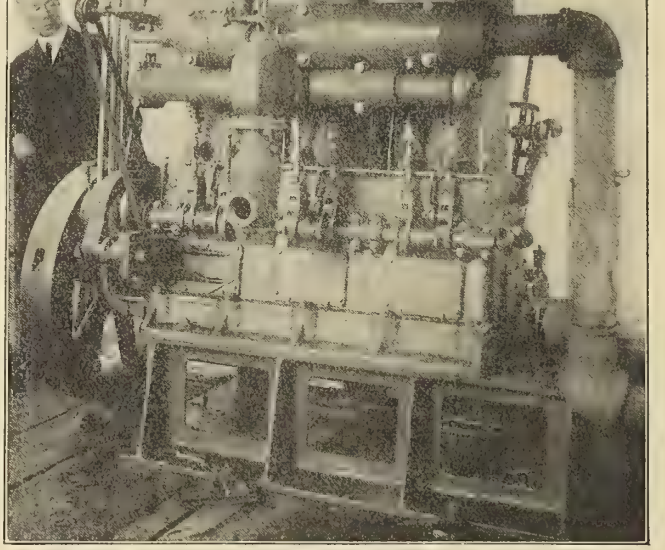


FIG. 2.—75-HORSEPOWER WOLVERINE ENGINE FOR PRODUCER GAS INSTALLATION

departure from, port could be established by using a power plant which would, to a large extent, eliminate the uncertainties of wind and weather conditions. This feature is well known to the coast trade, but the question of securing an auxiliary source of power which will prove reliable and economical is one which has been hard to find.

Fig. 3 illustrates a three-masted schooner, 109 feet long over all, 22 feet beam, 7 feet draft, which plies between Miami and Key West, Fla. This schooner carries freight and a few passengers between the two ports mentioned, and was formerly equipped with a 50-horsepower four-cycle motor. Recently this engine has been removed and a new 75-horsepower, three-cylinder, four-cycle heavy-duty engine installed. As the new engine was run on gasoline (paraffin) before the producer plant was placed aboard, a splendid comparison of operating cost was obtainable under precisely the same conditions. The fuel costs given in an extract from a letter from the manager of the line were thus obtained under normal every-day conditions:

FIG. 3.—PRODUCER GAS AUXILIARY SCHOONER

"We have always sent $65 (13/10/10) worth of gasoline (petrol) to make the round trip, and we sent instead this trip $10 (2/1/8) worth of coal."

FIG. 4.—PRODUCER GAS-DRIVEN RIVER BOAT

As this vessel makes two round trips a week it can readily be seen that the difference in cost of operation between gasoline (petrol) and producer gas amounts to over $100 (20/16/8) a week.

The light-draft river boat shown in Fig. 4 is 114 feet long over all, 23 feet 2 inches beam, 3 feet draft, and is equipped with a 75-horsepower producer plant. This boat will be used in carrying freight and farm produce on the East Florida canals. As an example of an economical freight carrier she will be unique, and further details regarding her operation, including the cost of fuel, etc., will be given at some later date.

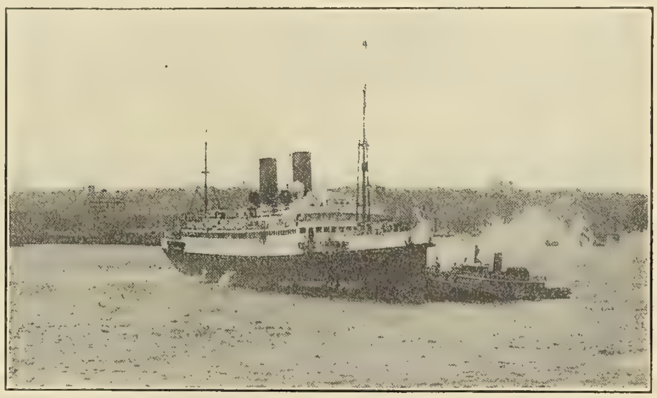
These are merely cases cited at random from the large and increasing number of craft equipped with producer gas, and all indications point to a very lively interest by the public whose business is identified with water transportation, as it presents an opportunity for increasing the earning power of an investment by an economical, simple and reliable source of power.

Steamship Espagne for the French Trans-Atlantic Service

The new steamship *Espagne* has been added to the French Line's fleet. Her general dimensions are as follows:

Total length	561 feet.
Length between perpendiculars.....	539 feet 4 inches.
Breadth (outside plating included).	60 feet 9 inches.
Depth to upper deck...............	38 feet 9 inches.
Total displacement	13,700 tons.
Draft	23 feet.
Gross register tonnage.............	11,155 tons.
Indicated horsepower (per contract)	14,000 horsepower.
Speed	19.5 knots.

The hull is of Siemens-Martin mild steel, and the upper work of high-tensile steel. She is double-bottomed nearly her entire length. She can carry 1,461 tons of water. She is divided into fifteen watertight compartments and has six decks, four of which extend from end to end of the vessel. The third 'tween deck is devoted to the cargo and bunkers, parcel and mail rooms, safe and passengers' luggage. This latter is accessible at all times during the voyage. On this deck are the store and provision rooms and the refrigeration rooms. The second 'tween deck is devoted to third class steerage passengers, the crew, etc. The forward deck of the first 'tween deck is set aside for first class passengers, the after part to second class. On this deck, alongside the boiler rooms, are the gallery and petty officers' rooms. On the main deck is the forecastle, 56 feet 7 inches in length, in which is located the hospital, infirmary, etc. The central part of the deck is devoted to first and second class passengers. The dining saloon has a seating capacity of 142. Tables to accommodate from two to ten persons are provided. The decorations are the Spanish style of the eighteenth century, ornamented with profusely carved dark wood and fine pictures. The second class dining saloon is the Louis XVI. style, and seats sixty-four people. The space between the first and second class dining rooms is divided into staterooms.



FRENCH STEAMSHIP ESPAGNE

The promenade deck has a length of 427 feet. The forward deckhouse contains four cabins-de-luxe, most luxuriously fitted up, consisting of bed-room, drawing-room and bath. A large first class social hall is provided, being 39 feet 4 inches by 36 feet, in the Louis XVI. style. This saloon provides sixty seats. It is beautifully lighted electrically. In the center of the main deckhouse is provided officers' accommodations and the wireless station, together with the operator's stateroom

A conveniently situated and beautifully decorated smoking-room is provided for each class of passenger. There are eight cabins-de-luxe, 119 first class staterooms, 35 second and 16 third class and 8 large steerage passengers' rooms, the total carrying capacity being 302 first class, 106 second, 90 third and 916 steerage. Thermostats regulate the ventilating apparatus and steam heat, and electric lights are provided throughout. The cabins-de-luxe are fitted with electric radiators and fans, which are under control of the occupants. The ship will carry 5,270 tons of cargo and 2,990 tons of coal.

Her boilers are twelve in number, of the cylindrical marine type, 15 feet 8 inches in diameter and 10 feet 11 inches long, with three furnaces, each of the Gurley pattern. They carry 200 pounds of steam, the grate surface being 743 square feet and the heating surface 31,290 square feet. The main engines are two in number, of the triple-expansion four-cylinder type, of the following dimensions in inches: 33.5, 54, 67 and 67, with 59-inch stroke. They are designed to give 7,000 indicated horsepower at 90 revolutions. The speed is 20 knots.

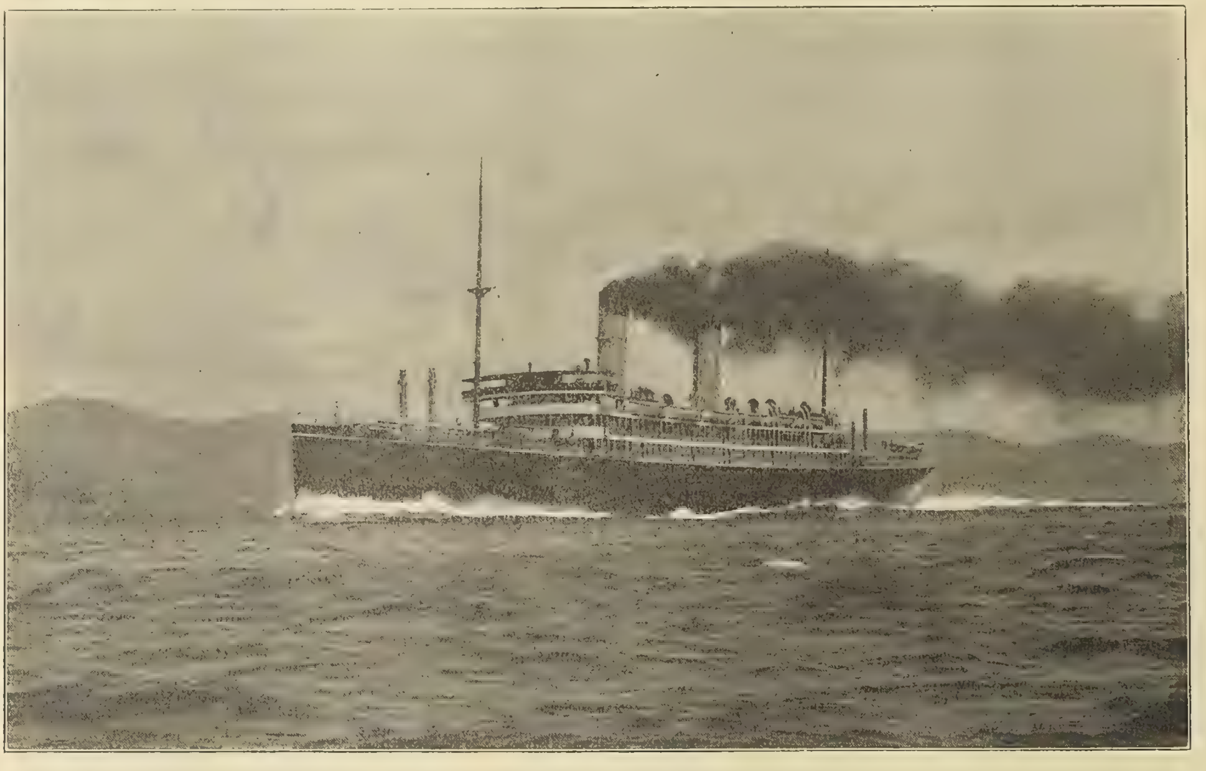
This ship is one of the best products of the Société Anonyme des Chantiers & Ateliers de Provence of Port-de-Bouc and Marseilles.

Japanese Turbine Passenger Steamship Shinyo-Maru

When the Toyo Kisen Kaisha gave the order for three 13,500-ton passenger steamships, capable of steaming 19 knots and driven by turbine engines, to the Mitsu Bishi Dockyard & Engine Works, Nagasaki, considerable astonishment was expressed in shipping circles, and the result was awaited with much interest. Two of the vessels, the *Tenyo-Maru* and the *Chiyo-Maru*, have been in service some time, and are regarded as among the most comfortable liners on which to cross the Pacific. Recently the third, the *Shinyo-Maru*, left Nagasaki on her maiden voyage, but without passengers, the scheduled trip beginning at Kobe. The turbines of the *Tenyo-Maru* and *Chiyo-Maru* were made in England, but those of the third vessel are the product of the Mitsu Bishi Company, which possesses the patent rights in Japan for Parsons' turbines, and to that extent the *Shinyo-Maru* is more completely Japanese than her elder sisters.

The new boat is double-bottomed throughout, with ten watertight bulkheads and numerous watertight doors, automatically arranged so that all or any one of them may be instantly closed from the bridge. The wireless apparatus has a working range of over 3,000 miles, and an automatic sounding apparatus is fitted which enables the navigator to find his position in thick fog by picking up land noises and bells that cannot be heard with the ear. This is the first sounding instrument of its kind to be introduced on trans-Pacific ships. The dimensions of the vessel are as follows:

Length	575 feet.
Breadth	63 feet.
Depth up to D deck	38 feet 6 inches.
Depth up to C deck	46 feet 6 inches.
Height between B and C decks	9 feet.



SHINYO-MARU

Capacity in Tons—

Gross	13,377.38
Displacement	21,600
Cargo capacity	9,262

Accommodation—

First class	210
Second class	57
Third class	754
	1,021

Speed attained on trial trips	21 knots.

The bulk of the cabin space is devoted to first class re-

OBSERVATION ROOM

quirements, and no trouble has been spared to make the traveler comfortable. All the latest inventions and innovations have been applied and the furnishing has been done in excellent taste, both comfort and health being studied. The berths were made by a London company, and are more roomy than those usually found on steamers. An electric reading lamp is attached to each berth in addition to the usual cabin lights. For wealthy travelers or invalids two suites of rooms are provided, each consisting of a sitting room, bedchamber and bath. Electric fans cool and ventilate each cabin, and there are heating arrangements for use in winter.

The first class dining saloon, as is usual with the latest type of ocean liners, contains only small tables, each seating six or eight persons. It is a commodious and well-ventilated apartment with windows opening onto the C deck. The grand stairway entering into the saloon is decorated in magnificent style. A large brocade panel forms the principal decoration, the subject being Cherry Blossom, significant of the spring and

LOUNGE

emblematic of the steamer's name *Shinyo,* or *Spring Ocean.* Immediately above the dining saloon is the drawing room, which is decorated and upholstered in excellent taste. It abounds in easy chairs and cosy corners. On the same deck are the writing-room, the lounge and the smoking-room.

On what is known as the A deck—the boat deck—there is a palm house, with beautiful palms and ferns, forming a pleasant observation saloon. Arrangements have also been made for passengers to dance and swim if they wish to do so—a space being left on the B deck for dancing and a swimming tank of large dimensions being placed forward of the dining saloon.

The second class accommodation is on the D deck. The cabins are very fine and even better than are found on many first-class steamers. The smoking-room and dining saloon are elegantly furnished for the comfort and pleasure of passengers who desire to travel at the cheaper rate. On E and D decks are the accommodation for steerage passengers. These quarters are exceptionally neat, clean and well ventilated.

For handling freight the vessel has been well equipped for loading and discharging cargo. She has twelve hatches, six derricks with twelve booms, also twelve 4-ton winches. The two foremost posts and booms are built for heavy cargo, having a lifting capacity of 25 tons each.

The total addition of steam tonnage to Lloyd's Register of shipping in the United Kingdom during 1911 has been 1,334,387 tons gross, and of sailing tonnage 21,864 tons gross, or in all 1,356,251 tons gross.

Of the tonnage added to the Register about 92¾ percent consists of new vessels, practically all built in the United Kingdom. The largest item among the other additions to the Register are those of vessels bought from foreign countries for the United Kingdom, viz., 82,757 tons.

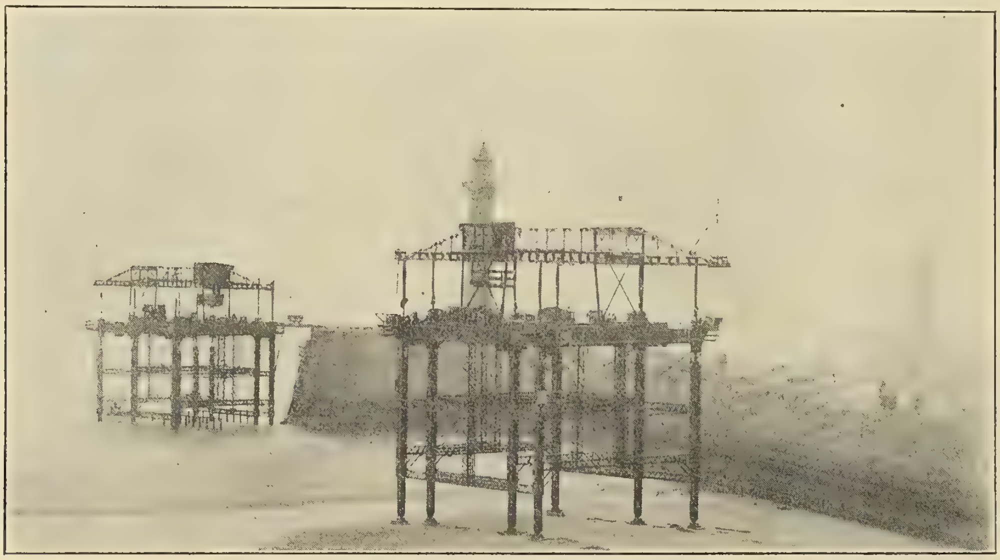
The gross deduction of steam tonnage from the Register amounts to 854,483 tons, and of sailing tonnage to 163,551 tons, or in all to 1,018,034 tons. Of the steam tonnage nearly 24 percent and nearly 26½ percent of the sailing tonnage included in these figures have been removed on account of loss, breaking up, dismantling, etc.

The tonnage sold to foreign owners during 1911, which, however, includes a considerable amount intended for breaking-up purposes, is returned at the record figures of 730,485 tons. The steam tonnage deducted on this account is 616,546 tons, and the sailing tonnage 113,939 tons, or over 72 percent, and about 69½ percent, respectively, of the gross deduction. The total tonnage deducted under this head is 210,031 tons higher than the similar figures of 1910.

Locomotive Marine Stages

The problem of carrying on work in a rough or smooth sea without delays and loss due to disturbing influences has been solved in an interesting way in England, where there has been in successful use for more than a year a form of locomotive marine stage invented by a civil engineer of Scrubwood, Wendover, named Robert A. A. S. Piercy. The first of these stages was tried at Peterhead, Aberdeenshire, where it was employed with great success in removing a ledge of granite that extended across the entrance to the harbor and endangered the vessels of the fishing fleet at low tide and during storms. Ten thousand tons of rock were blasted and removed with the aid of the locomotive stage. Two similar stages are in use at Whitby harbor and one at Dover.

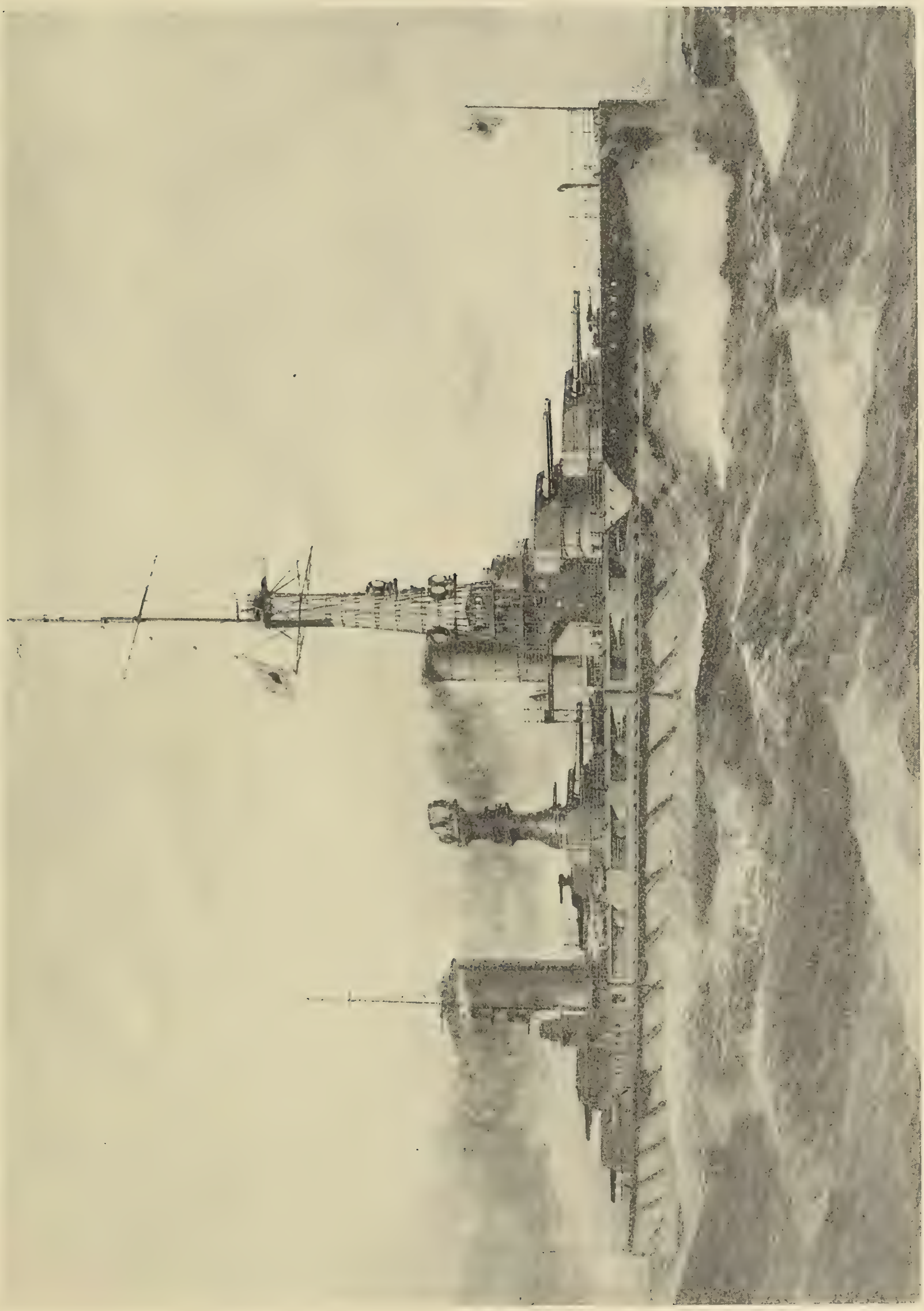
The means by which mobility is obtained is ingenious and of great interest. The staging consists of two principal members, both of truss or bridge construction. One is considerably smaller than the other and is placed inside of it, as shown in our illustration. Each of these is supported by four vertical legs or spuds of Oregon spruce, 80 feet in length, placed at each of the four corners and enclosed by a truss column. The columns are tied together by horizontal trusses, giving both the outer and inner structures independent rigidity in all directions. The spuds work in guides, and are capable of vertical movement, each independent of all the others. Means are employed for raising and lowering the spuds. When the four spuds of the inner structure are raised clear of the bottom the entire weight of the stage is supported upon the four spuds of the outer structure, and vice versa.



MOVABLE STRUCTURES USED IN HARBOR ENGINEERING WORKS

By suitable means, not shown, the bridge carrying the inner structure can be moved longitudinally of the outer structure after its spuds have been raised. Its entire weight then rests on rollers that travel on the upper track portion of the second structure. When it is desired to move the outer structure its spuds are elevated until the weight of the whole stage is carried by the spuds of the inner structure, when it can be advanced upon the rollers upon which the lower track portion rolls.

If the nature of the work to be done is such that radial motion is very desirable, the side members of the outer structure can be bent to the arc, so that the movable bridge can turn on its center like a turntable.



ARGENTINE BATTLESHIP RIVADAVIA, OF 26,500 TONS DISPLACEMENT, UNDER CONSTRUCTION AT THE FORE RIVER SHIPYARD, QUINCY, MASS.
(For complete description, see INTERNATIONAL MARINE ENGINEERING, May, 1910, and January, 1912.)

An Air-Reversing Propeller

While the air reversing propeller is not a new idea, that designed by L. H. Coolidge, marine architect and engineer of Seattle, Wash., for the barkentine *Archer,* which has been fitted with a marine producer gas installation, is not only the largest yet cast, but it combines a number of new features. One feature of this big propeller, which is 82 inches in diameter, with maximum pitch of 82 inches, is that a center is used that never before has been brought into play. This propeller has been designed and cast with an extreme nicety as to detail. The workmanship on it is practically perfect. The trunnions have been protected with jib blocks. Every bit of space has been cared for and each recess is nicely machined out, perfecting a nice working fit. Another difference in this particular propeller is that the propeller is carried on the covering bushing, which is four feet long and ½ inch thick, boshed up to one inch at the after end. It lies in lignum vitæ. The bushing is riveted and boshed up and the hub is put on with threads and three keys.

The wheel is carried on a 6¾-inch steel propeller shaft, on the end of which is fitted a triangular bronze fitting having recesses which engage the trunnions on the roots of the propeller blades.

The hub is cast in two parts, the forward part being carried on the bronze casing, which extends through the stern tube into the vessel and has yokes and collars at the inner end to which the plungers from the air cylinder and dash pots are attached. This casing is movable fore and aft over the propeller shaft by means of compressed air, admitted to the cylinders on either end of the pistons. The air control levers are mounted on a standard which is situated near the throttle of the engine so that it can be easily reached by the engineer.

COOLIDGE AIR REVERSING PROPELLER

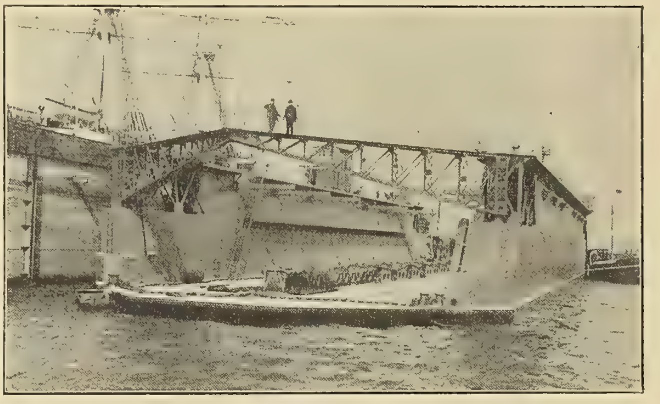
The cap or after part of the hub is provided with an adjustable center by which the desired pitch of the blades is fixed. This center also carries a thrust load to the propeller shaft. The cap or after part of the hub is secured to the forward half with six Tobin bronze studs.

The hub and blades are cast from manganeze bronze, while the bushings and minor parts are red bronze. The weight of the propeller is practically one ton. The blades are interchangeable and the vessel carries an extra set, this being thus equivalent to a built-up propeller. Ample bearing surface is provided for the blades and the hub is designed with sufficient strength to withstand without injury anything which would break down the blades. The blades can be handled practically fore and aft. The release clutch is between the engine and propeller, so that the engine can be run without the propeller being in action.

In the accompanying illustration the propeller is shown as it appeared in Mr. Coolidge's office. The markings on the blade shows the cut made by the grinding wheels.

New Floating Dock for Rotterdam

A new double-sided self-docking floating drydock, 365 feet long and 81 feet wide, has been built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., for the Wilton Engineering & Slipway Company, Rotterdam. The dock is of the type known as the bolted sectional dock, and was designed by Messrs. Clark & Stanfield, of Westminster. This dock combines the advantages of the great longitudinal strength of the box type with facility for self-docking. The dock is built in three sections, which are bolted together, and are disconnected only when self-docking is required. Any two sections of the dock can lift the third section to a height sufficient to allow barges and workmen to pass underneath. Electric-driven centrifugal pumps are used, independent sets being furnished for each section of the dock.



SECTIONAL FLOATING DRYDOCK FOR ROTTERDAM

Steamer for West Indian Trade

About the end of November Messrs. Russell & Co. launched from their extensive yard at Port Glasgow, Clyde, the screw steamer *Crown of Toledo,* for the Clyde and West Indies service of Messrs. Prentice, Service & Henderson, of Glasgow.

The dimensions of the *Crown of Toledo* are: Length between perpendiculars, 455 feet, 56 feet 3 inches beam, extreme, 39 feet molded to shelter deck. Her gross tonnage is 6,100 tons, and she has been built to the highest class in the British Corporation Registry to secure a full Board of Trade certificate for passengers. The masts are the latest type of twin masts, forward and aft, for the purpose of carrying a large number of derricks for rapid cargo handling. There is a complete installation of electricity throughout and all the fittings are first class.

As Messrs. Russell & Co. are not engineers the machinery is supplied by Messrs. Dunsmuir & Jackson, Govan. The propelling engines have cylinders 28, 46 and 77 inches by 54 inches stroke. There are four boilers, each 15 feet by 12 feet, designed for 180 pounds working pressure. There are three furnaces in each, 3 feet 8 inches diameter inside, of Deighton section Stephen & Gourlay ends, fitted with Howden's forced draft.

Among the auxiliary machinery are eleven steam winches of Clarke, Chapman & Company's latest Cyclops pattern, and windlasses, also by Clarke, Chapman & Company, of the direct-acting grip type. The steam steering gear, by Caldwell & Company, is fitted aft, and is controlled by telemotor gear. The pumps are of Weir & Company's make.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Weak Points in Steamship Design

Common sense is as great a necessity in marine engineering and shipbuilding to-day as it ever was. "A" says put in a condenser of so many square feet of cooling surface to take care of the steam from such and such size engine. Now "B" orders a ship of the same dimensions and power, but a different yard builds it, and they say, "How many square feet of condensing surface did Mr. "X" put in that boat," and as soon as they find out, Mr. "Y" puts in one of the same dimensions. There may be a change of detail, but the same blessed number of square feet is there, and so are the same troubles. Oil in the boilers? Why, of course, that is where it should go, so that the cost of an extractor can be saved; and again, oil gives no trouble on a drawing. Feed-water heater? Yes, have one by all means; there is bound to be a saving. Take the steam from the receiver or boiler and throw the exhaust from the auxiliaries into the condenser. That is where the saving comes in. Evaporator? What use is an evaporator, anyhow; there is plenty of water in the ocean, and you can blow down. Steam separator? All nonsense; there is room between the rods and packing for water to leak through, and what are relief valves for, anyhow? Only an ornament. What is the coal pile for if not to use as much of it as you desire?

Poor Mr. Engineer, these things are nothing to you. What if your crown sheet comes down, and you lose your ticket? There are others. And again, time in the drawing room is more important than wasting it by trying to analyze a problem as it should be. I have in mind the chief engineer of a prominent shipyard who, if he saw you computing anything, had a fit of several hours' duration. You were expected to copy from other drawings and say: If $x = 1\frac{1}{2}$ inches and $y = 3$ inches and you want to know V_1 from the V on the other engine, then all you have to do is to perform a parrot stunt, and say 1.5 inches is to 3 inches as V is to V_1. When you have finished this rot, you have an engine that looks like the deuce, and which you are expected to modify by eye. Talk about scientific design! The world is full of it. But to get back on the track of our trades.

First consider the separator. Think what it would save in one year. Now take the practice of fitting an automatic valve to the well of a separator and let it dump into the filter box. Oh, is this not joyful, when we can pipe right from the well to an auxiliary or auxiliaries having no flywheel, for they can run on steam of dryness factor of .70 as well as not? Right here is a point of economy. What a saving on packing; what a saving on relief valves, and what a saving on nerves! A separator is one of the most important factors of economy; and how much better the old mill works on steam with a little less water, and how much better the indicator diagram looks. You feel as though there was a safety-gate between you and eternity.

Next we come to the grease extractor. Is it not fine to come into port, and, after cooling down the boilers, get into them, and see the total absence of grease, and see the surface just salted to the proper point? Then you come out, feeling just fine, and knowing that there is no sign of corrosion or pitting; and then you go over the feed line, filter box, etc., renewing the burlap in same, and thinking that now you do not have to depend on those and the product of the farm. Straw is good for some things, but not for others. You look over your cartridge, and perhaps you have to renew one in the extractor; but, pshaw! this is a pleasure. You look at your heater and that is clear.

Next comes the heater. Why be satisfied with an evaporation of 8 pounds of water per pound of fuel when you can just as well evaporate 10.5 to 11 from and at 212 degrees if you get the proper temperature of feed to start with? Then your auxiliaries are sending their waste heat, to a place where it counts, and you are showing the owners results. What is your saving? Why, 1 percent for every 10 degrees. You are getting steam without any trouble, and when you come into port your log shows a fine run and small coal consumption. How do you feel? There is no need to ask, the results are evident.

Now your evaporators need looking over. Well, they have worked well on the run; they have given the extra feed, and they have required very little attention; the density has been kept proper, and the coils are very little coated. And, by the way, boys, I have a pump that is designed for the work, and you do not have to stand with a microscope to see if it is running. This pump is not too large, neither is it small; but at a decent number of strokes or double strokes, you can see it moving, and need not wonder if the confounded thing has shut down and you have the warning from another source. Then, again, I can get that water through at the proper temperature, because it is designed properly, and altogether I am happy. What is the saving? Well, boys, some day I am going to take you out for a walk, and I am going to take two conditions and show you the saving in good plain English—no calculus, nor any juggling of figures—but the plain log-book talk. Now that we have all of these, is it not fine to indicate our engines and get our valves where we want them, and see the fine steam line, the fine compression curve, and get a noiseless engine, and one in which we have the work as nearly equally divided as it is possible to get it?

Engineers, listen! This is up to you. It is up to you to go to your owners, and to protect their property and your own lives and nerves. You will never get it out of the drawing room, for they are going to give you as little as is possible. It is their pleasure and privilege to forget the thing as soon as it is out of their hands and to sit by a warm fire at night and read, while you, who are out on the stormy billow have it all to look after and keep up. I say that the sea-going engineer has got to assert himself, and he can be a great factor in the proper design of ships and engines, and it is his duty to do so. The owners are, as a rule, business men, and why they do not insist on having all that goes for economy is beyond me. I need not call your attention to the ships running to-day that are simply coal eaters; and why? Because they will not install saving appliances; and again why? Because they won't listen, and permit you to prove to them what you can do. A naval architect and marine engineer should insist upon installing everything that he knows is good, and which will show a saving compatible with the expense of the installation; but some of them don't know, others don't care as long as they get the commission to design something that makes a noise like a steamship, boat, or other floating object.

Now here is Mr. "A." He is a fine engineer, and has been to sea longer than I have; and as I have the commission to design this steamer I am going to have a talk with him, as he is going out as chief of her when she is built. I go, and have my talk. I learn the weak points of his present ship, and I learn many things as I talk; and, as my design takes shape, I call him in and say: "Mr. 'A,' there is the design; have you any suggestions to make"; and perhaps he has, and I discuss them with him. I tell him I am going to design the engine, thus and so, and give him plenty of room. I am going to cut away from this grand and noble thing called shipyard practice, and I am going to make all my main bearings longer than this so-called practice, and I am going to design my bed-plate so that I won't have a rocking-horse such as this good old shipyard practice produces, and I am going to reduce all clearances, and use piston valves—not plugs, you understand—through which you can see daylight when they are cold; and I show him that I have designed the guides, which are of the all-round type, so that there is no deflection, because I have spent some time and computed them and designed for stiffness as well as strength, which is not the good old practice. And oh, Mr. "A," lest I forget, I have incorporated a separator on the main steam line, an evaporator, a heater and grease extractor, and my pumps are all designed to take care of working conditions, as well as over-load without giving you heart failure. And here is the hull—you see, I have made the engine seating very stiff and rigid. You will note that I have arranged certain details as per your ideas. And, say, they are fine, too. It costs no more, and may even cheapen the cost of construction.

Now, what is the result? I go to the owners, and go over the figures and prove to them, not by hypothetical cases, but by actual results, that their new boat will save them so much more per year and carry freight for less per ton mile than this old ship. What is the result, again? This ship is built and the engineer feels that he is of some moment. He takes great pride in her, and he proves my figures, and by his ability he shows even greater economy than I promised.

Are such men worth having? Is it an impossible condition? I am willing at any time to prove that it is a true condition, and even underrated than otherwise. Please remember that it is one thing to build cheaply and have an expensive ship and lose money, and another thing to go to a little more expense in installing proper appliances in a ship and making her a money-maker. There is still another thing; let us have bright, thoughtful knowledge-seeking engineers, and remember they are the boys that, with proper means, can show results; and they, as a body, are only too anxious and willing to show their ability. I admire them; I have been one of them; and if their advice was taken many a failure would have been a success.

There is in the average shipyard a feeling of contempt for the sea-going man—and justly so, because when a sea-going engineer is selected to superintend construction, they know he will insist upon having certain things. I know several inspectors who are sea-going engineers, and they have been handicapped by the builders, and even by letters written by the shipbuilding company, about their inspector, but in every case the owners have upheld him. I can point to one case in particular, and the work shows how faithfully he performed his duty; and I can say while he had his trouble, his work speaks for itself, and the performance of the boats are up to expectations. Let us as naval architects and marine engineers welcome the assistance of the practical engineer, and have his confidence, and get his views, and I guarantee that his assistance and suggestions will not only react to our credit as professional men, but to the advantage of those who employ us to do their designing.

Charles S. Linch.

Between the Engine and the Propeller

Every one who has gone down to the sea in ships as a marine engineer will know that a good proportion of his trials and tribulations have occurred in the region between the engine and the propeller. Whether he be a Scotsman or not he will always regard the shaft tunnel with an air of cautious reserve, and he will never be persuaded to take the thrust block into his confidence as a bosom friend. Things are far too likely to happen there, particularly if the vessel is at all cranky and throws sudden and unexpected stresses upon the propeller shaft and its belongings.

Here is a little incident which may illustrate the force of these remarks. While a vessel was working its way through the Bay of Biscay in weather which would not have suited a Cook's tourist it was noticed that one of the couplings on the propeller shaft seemed a good deal looser than was consistent with the safety of the vessel. The engine was stopped and the engineers set to work to tighten up the coupling bolts

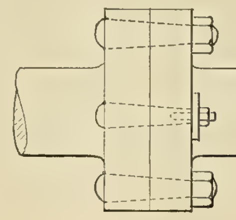


Fig. 1

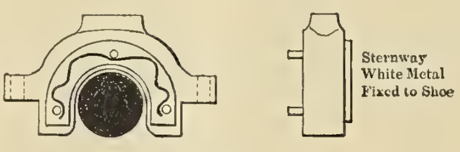


Fig. 2

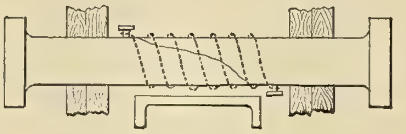


Fig. 3

with a key and a quarter-hammer. One of the coupling bolts must have been very badly strained, for when pressure was applied in the manner mentioned the nut and the screwed end came away suddenly, the broken end showing a rather crystalline but quite a clean, new fracture. This was a predicament which had to be faced pretty promptly, as the vessel, having no way upon her, was properly in the trough of the sea. An attempt was, of course, made to drive out the shank of the coupling bolt to put in a spare one, but it was far too tightly wedged in for such simple measures to be taken. There was, of course, no time to drill the faulty bolt out, so that the temporary measure shown in Fig. 1 was adopted. An inch tapping hole was drilled about 4 inches down into the bolt, and after the hole had been tapped a stud was put in and forced tightly home. In the meantime a large washer had been made out of a piece of boiler plate. This was slipped over the end of the stud and a nut was screwed on as tightly as possible. In this way it was reckoned that even if there was a tendency for the stud to work loose and drop out when the engines started to run again this would prevent it, and as a matter of fact this makeshift repair carried the vessel through until the next port was made, when the broken bolt was drilled out and a spare one inserted in its place.

Another little incident which is not without its peculiar

interest may be related. In one ship which traded between Great Britain and the United States it was found that there was not sufficient engine oil in the stores to carry the engine home to its British port, and some more oil was ordered in the American port of call. This oil did not recommend itself to the engineers on its arrival, as it was very thick in appearance. No aspersion is here cast upon American oil, as good oil can be got in the States as in England, only it happened that the engineers struck a bad streak of luck with this particular consignment. As they were very doubtful about it, and as it was too late to change it, they came to the resolution to use it first of all upon the thrust block and see how it went on before they used it on the whole engine. They were afterwards very sorry that they used the thrust for experimental purposes; they wished it had been a donkey pump. They put the oil into the thrust at 6 o'clock at night, and it seemed to work all right. The thrust block had a continuous flow of sea water through it, which, of course, helped matters considerably, and no heating whatever was perceptible. About 3 o'clock next morning, however, the third engineer, who was on watch, awakened the first out of a deep and virtuous sleep to inform him that matters of interest awaited him in the engine room. By the time he had got there the main bearings of the engine were getting uncomfortably warm, and one of them was sparking. This was due to the fact that the engine shaft had worked forward because the white metal liners of the thrust block shoes had simply been ground away for an eighth of an inch. The group of sketches in Fig. 2 will explain the arangement which was in trouble. On the headway side of the thrust block shoes there were white metal loose liners, supported on three studs, as shown, while on the sternway side the white metal was fixed to the shoe. When the engines were stopped and the thrust blocks taken out it was found that the oil-ways shown in the sketch were gone altogether, and the headway liners were hanging loose. These were therefore taken off and new oil-ways were cut in them. In order to make up for the lost thickness mentioned above some iron liners ⅛ inch thick were made and placed on the studs behind the white metal ones, being cut and drilled to the same dimensions as the white metal. This effectively took up the wear. Then the thrust block and oil boxes were thoroughly cleaned out before the shoes were put back, and a change back made to the kind of oil which had been used on the outward trip, it being resolved that whatever part of the engine had to make out with the new oil it should not be the thrust. As a matter of fact the new oil was far too thick and clogged up the oil-ways, and when some of it did get down to the working surfaces it could not stand the pressure upon them.

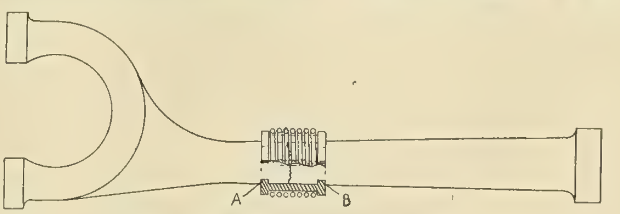
It is, fortunately for the peace of mind of the marine man, not often that anything so serious happens as the total fracture of the propeller shaft, but it is an eventuality which has to be faced, and it may therefore be not without interest to relate how an incident of this description was coped with. The sketch in Fig. 3 will illustrate the way in which a broken tunnel shaft was repaired. The trouble originated in the bearing, this becoming weak because it frequently got hot and was cooled out again too suddenly by passing sea water through the water-service pipe. This heating of the bearing was in the case considered quite unavoidable, as it was due to the sagging and hogging of the ship when she was loaded and light. The result was, however, that it broke in the bearing, and this immediately resulted in the fracture of the shaft as shown. Fortunately the vessel was not far away from the home port when the accident happened, so that strictly temporary measures were taken. The broken bearing was first of all cleared out of the way, and then the shaft was shored up so as to bring the faces of the fracture close together. The shaft was a steel one, and the alternate cooling and heating had made it quite crystalline, so that the fracture was a very clean one. When the shaft had been brought into position wooden steadiments were made out of hatches to take the weight of the shaft. Bolt holes were drilled into the shaft, as shown, and bolts secured to it. Some heavy chain was secured from the deck, and this was wound round and round the shaft, one end being secured by means of a shackle to one of the bolts. The direction of winding was such that when the boat was going ahead the twist on the shaft would tend to tighten the chain on the shaft. It was brought into very tight contact with the shaft in the first instance by using strong chain blocks to draw it tight, and before the tension was released the other end of the chain was secured by a shackle to a bolt in the other portion of the shaft. This was a somewhat unconventional mode of repair, but it answered well in practice, and the ship was brought home safely by running at a little over slow speed, and taking care never to put the engine astern. It may be mentioned in connection with this accident that on examinations of fractures in propeller shafts, except where they occur at the thrust block and near the coupling flanges, it is nearly always found that they assume a diagonal direction across the shaft, and one could think, therefore, that possibly the thrust along the shaft has as much to do with the fracture as has the torsion.

In concluding these brief notes on troubles between the engine and the propeller, there is no intention to discourage the younger engineers, but rather to point out to them what might happen, in order to put them on their guard. The incidents also point to the fact that, other things being equal, the nearer the engine is to the propeller the better it is for the peace of mind of the engineers. Observer.

Repairing an Eccentric Rod

As my repairs of the coupling, or rather shaft, in your August issue seem to have met with favorable notice, I give a sketch of a repair I once made at sea. In this case, however, a new eccentric rod was put in on our making port.

The break occurred early one morning when the *Santos* was about a day and one-half from our English port. No damage was done when the eccentric rod parted, and as shown in my drawing the break was very clean. I had the "Y" part taken out at once and put in the "machine shop," as it was



REPAIR OF A BROKEN ECCENTRIC ROD

called aboard ship. All there was in it was a lathe (self-acting) and an emery wheel.

The length of the rod below the break was about 4 feet 6 inches. I smoothed up the face of the break and quick-punched the top half, drilling a ¾-inch hole about 2 inches deep in it. I took considerable care to get this hole exactly in the center of the rod and drill its mate in the other broken part so as to have it match.

The long piece was awkward to drill, as I had to take the tail stock off the lathe and block up against the bulkhead, and feed the piece forward for drilling with a small screw-jack. Getting this right in the center was a lot of trouble, and even with all my care the pieces did not exactly match when I brought them together with a pin to hold them, as shown in my drawing.

The feet of the "Y" part were about 10 inches wide from outside to outside, and of course there were holes for the link brasses, and I had no trouble in bolting this "Y" piece by these

feet to the face plate of the lathe and centering it, and with a dog on the drill I could drill the hole with great ease. Before taking the piece out of the lathe I turned the groove *A*, which was about ¾ inch wide and 5/16 inch deep. I put on the back stop (or what they call here a steady rest, but on this point there seems to be a row), to help me steady the work, which stuck out about 14 inches, if I remember right. This part of the work was easy, but I had trouble holding the long piece while I cut the groove *B*.

I turned up a sleeve, which is cross-hatched in my drawing, out of a piece of machinery steel, and it took me about 16 hours to drill through it and run the taper, which I could do on the lathe as it had a compound rest, but I had to reset the tool as my feed was not sufficient. I made an arbor and turned off the outside as shown. The nice part of the work was to get the rings at the end of the steel sleeve to meet the grooves, but after sawing this sleeve apart with a hack-saw, or rather a good many of them, and doing a little scraping, I made a good job of it, and got the half of the sleeves out as shown, and wound the outside with copper wire, and with my heart in my mouth I started up slow, but the mend held, and we got through all right, and although we were considerably late the loss of time and cost of repairs was a great deal less than getting a tow. Coupling.

Minor Troubles of the Marine Engineer

Perhaps it is a good thing that all the difficulties which assail the seafaring engineer are not big ones; he might collapse under them. The only thing to remember, however, is that the small troubles, unless taken in the proper manner, are apt to become big ones, and a word or two may, perhaps, be permissible on one or two small points which ought to be and probably are known to every marine engineer who has been taught in the school of experience. As, presumably young beginners read the columns of the *International Marine Engineering* as well as old stagers, perhaps the editor will permit brief reference to elementary matters.

In the simple matter of grinding in plug cocks, for example, there is a right and a wrong way of going about the job. The wrong way will probably lead to a great waste of

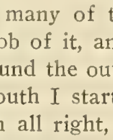


FIG. 1

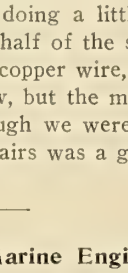


FIG. 2

time, and time is sometimes of importance at sea. All these plug cocks will be found to have hard places which, in the ordinary way, will take a lot of grinding down. One of the easiest and quickest ways of finding these hard places is to chalk down the plug in three places, put it in its shell and give it a turn. Then on taking out the plug and examining it the hard places will be distinctly shown. These portions should be dealt with carefully with a smooth file, and the plug should then be chalked and tried again until all the hard places have been taken off. If this simple proceeding is taken it will be found that the actual operation of grinding can be performed in very much quicker time and much more easily than if the filing had not been done.

Then, again, junior engineers, who flatter themselves that they can make a joint, frequently let themselves in for trouble by not nursing the joint properly when it is put into commission again. The result is that the joint before long begins to leak again, and the junior gets himself into trouble. Whenever a joint has been made when the pipes are cold it should be remembered that they should be gone round again with a spanner and tightened up as soon as the pipes are warming. It will be found that some more can be got on the nuts no matter how tight they were before. This should be repeated four or five times and the joint will then not get a chance to leak. It is a simple thing to mention, almost too simple to write about, perhaps—but anyone who has monkeyed on with a leaking joint when it was impossible to shut down will know its importance.

There are all sorts of little things about the steam installation on board ship that can hardly be classed as important, and yet they count. It would, perhaps, be unsafe to say that the engineer can be best judged by the way he tackles detail troubles, as this is not strictly correct, but there is no doubt that the man who does look after the little defects is a great source of comfort to the owners of the ship. Sometimes, too, these detail jobs require as much ingenuity as the bigger ones. For example, it was found on one ship that one of the boiler check-valves would not keep tight when it was shut down and when the steam was off the boilers this valve was taken out. It was found to be broken as seen in Fig. 1, and in addition the miter on the valve and valve-seat was found to be in a very bad condition. The reason that the wing broke on the valve was due to the clattering of the valve while it was at work and was probably unavoidable. It may be said in passing, however, that to avoid such troubles, check-valves of this description should be made stronger in the wings than ordinary valves, and another thing which seems to be supported by experience is that valves having three wings are much better in practice than four winged valves, as they are not so likely to "gag" or get forced up and held tightly against the seat. The fact of one wing breaking as shown caused the valve to twist a bit, and this meant that it did not come down on its original seat, and so spoiled the mitering.

As so often is the case on board ship, unfortunately, there were in this instance no spare valves available, so that a minor repair became necessary. First of all the remaining part of the broken wing was chipped off flush with the top part of the valve as shown in the second sketch, and then two ⅝-inch tapping holes were drilled close to each other in the head of the valve as shown. They were then tapped and suitable studs were then screwed in so as to form a temporary wing to guide the valve better. When this was done the valve was next ground in and new miters were thus made on the valve and seat, and the parts were then put together. It was then found, on setting the boiler away again, that no more trouble was caused by the valve, and the repair lasted perfectly satisfactorily until a home port was reached, when a new valve was procured.

It may seem absurd to mention such obvious and elementary matters as the above, but the writer is convinced that nine-tenths of the trouble at sea arises from causes which were originally of the most trivial nature, so that nothing in the nature of supervision and repair is too trivial to be worthy of attention. Junior.

Report of Bureau of Navigation

The Bureau of Navigation reports 72 sailing, steam and unrigged vessels of 14,918 gross tons built in the United States and officially numbered during the month of February, 1912. Forty-four percent of this tonnage consisted of steel steam vessels, the largest being the passenger ship *City of Detroit III.*, of 6,106 gross tons, built on the Great Lakes.

Review of Important Marine Articles in the Engineering Press

Torpedo Boat Soridderen for Danish Navy.—Recently completed by Messrs. Yarrow & Company at their Scotstoun works, this vessel is 181 feet 9 inches long by 18 feet beam and molded depth of 10 feet 4 inches. High-tensile steel has been used in hull, where great structural strength was required. Machinery consists of Brown-Curtis turbines and two Yarrow boilers of the latest type, working at 265 pounds pressure. Armament consists of two 7.5-centimeter quick-firing guns and five torpedo tubes. On trial mean speed of 27.217 knots was obtained for three hours with 4,800 shaft-horsepower. 400 words and photograph.—*Engineering*, October 20.

Twin-Screw Steamer Chelohsin for Vancouver.—This new product of the Dublin Dockyard Company has recently made her maiden trip from the builders' yard to Vancouver, where she will go into service for the Union Steamship Company in the pasenger and light-freight business on the protected waters of British Columbia. The vessel is 175 feet between perpendiculars, of 35 feet beam, and has four decks devoted to passenger accommodations. She was built under survey of the British Board of Trade and the British Corporation, and is specially strengthened in the shell plating forward and in all the deck and pillar construction. The propelling machinery consists of two sets of triple expansion engines working at 185 pounds pressure and supplied with steam by two specially large boilers designed for burning inferior coal. On trial the *Chalohsin* made 14.29 knots in service conditions and fully 13 knots with 300 tons of dead-weight on board, both performances being in excess of the guarantee. 850 words and photograph.—*Engineering*, February 9.

The Spanish Dreadnought Espana.—In February there occurred at Ferrol the launching of one of three Spanish dreadnoughts now building. The dimensions of the new vessels are: Length, 435 feet; breadth, 78 feet 9 inches; depth, 42 feet; draft, 25 feet 6 inches; displacement, 15,700 metric tons. The main battery consists of eight 12-inch guns; armor belt is 9 inches in thickness. Parsons turbines are used and the anticipated speed is 19½ knots. The manner of building is interesting. In 1908 tenders were called for by the Spanish Government for the building of three dreadnoughts in Spain and the reconstruction of certain dockyards under conditions whereby the larger part of the labor was furnished by the Spanish people and all of the engineering work by the contractors. The firms getting the awards were Sir W. G. Armstrong, Whitworth & Company, Ltd.; John Brown & Company, Ltd., and Vickers Sons & Maxim, Ltd., and under their directions this work has gone on. Simultaneously with the completion of their ships the Spanish Government is getting the benefit of a practical training for their dockyard force as well as the thorough reconstruction of the yards themselves. 600 words and sketch.—*The Engineer*, February 9.

The Economical Speed of Ships.—By George Harrison. A brief and clear description of a graphical method of working out the most economical speed for a given ship on a given voyage when the coal consumption at different speeds is known. Variations of the problem are its solutions when the vessel is steaming with and against a current of known speed. An important problem explained in words of one syllable. 1,800 words.—*Cassier's Magazine*, February.

The Safety of Ships at Sea.—Paper by Prof. W. S. Abell, M. I. N. A., before the Liverpool Engineering Society. The whole question is divided into two headings: "The safety of ships at sea must be influenced by two considerations: (*a*) Whether the control of the vessel is injured in any way owing to the breakdown of the engines, steering gear or rudder, or (*b*) whether the buoyancy of the ship is impaired by flooding, caused by loss of hatches, by working of the structure, or by collision." The data available for such a study is necessarily very limited, and consequently the results are claimed only for general cases. Elements considered are the ship's statical stability, ratio of breadth to depth, and the proper use of water ballast. Wind pressure is given considerable attention, both quantitative and qualitative. From an analysis of Lloyd's Register a proper ratio of breadth to depth is deduced for probable worst weather conditions. 3,300 words.—*The Steamship*, February.

The Salving of the Submarine Boat A3.—The damage caused by the collision of the submarine boat *A3* and the gunboat *Hazard* has been proved to be very serious. Doubt has been expressed as to the advantage of raising the vessel except as a means of discovering possible improvements in future design. This is not important, for the later boats are immensely superior to the original boats of the A class, particularly in the elements of design tending to minimize disaster. Owing to the exposed position of the sunken vessel the task of raising it has been large. At first Admiralty lighters were put upon the work, but later the assistance of a salvage company was obtained. The procedure now being adopted is the use of air in rubber tanks by which the buoyancy of the vessel is to be restored. These tanks are filled with water, sunk into position within the vessel and air forced in at pressure high enough to expel the water. By this means it is hoped to float the vessel to a nearby dockyard. 900 words.—*Engineering*, February 16.

The Fottinger Hydraulic Power Transmitter.—Its Advantages with High-Speed Turbines. A very brief statement of what the Fottinger invention is and what it accomplishes, illustrated with diagrams showing saving in space of the machinery installation on vessels of several types supplemented by figures of weights and steam consumptions involved. One example is that of a cross-channel steamer of 1,600 tons displacement and 4,800 horsepower. With direct-acting turbines the propeller revolutions are 600, the machinery weight 166 tons, and the steam consumption with saturated steam is 15.45 pounds; with the Fottinger transmitter the propeller revolutions were reduced to 450, machinery weight to 75 tons and steam consumption to 14.22 pounds. 800 words.—*The Steamship*, February.

Liquid Fuel.—A review of a paper by Captain Edoardo Gianelli, of the Italian Corps of Naval Architects. In this paper the author deals with the various sources of supply of petroleum, with its characteristic features, and with methods used for its carriage and storage. He then reviews the different systems followed for firing boilers with liquid fuel. Speaking of atomizers, he divides them into three classes, steam jet, those using compressed air and those in which the liquid fuel is under pressure. The last of these, in the author's opinion, meets with the greatest favor at the present time. In fitting burners to boilers an advantage of 10 percent greater efficiency can be obtained by using independent atomizers instead of having one common air receiver. Any type of boiler can be adapted for burning oil, but those boilers are preferable which have long furances and not too much heating surface exposed directly to the flame. An ample combustion chamber is of special importance. Tests have shown that about 0.8 horsepower per square foot of heating surface can be obtained.

With watertube boilers having an ample combustion chamber and good atomizing 0.6 horsepower per square foot may be safely figured. Captain Gianelli states that the only serious objections to oil fuel are its high cost and the difficulty of arranging for its supply. In Italy oil fuel costs about twice as much as coal, ton for ton, but owing to the greater heating value of the oil its real cost is only about 30 percent greater than coal. 950 words.—*Engineering,* February 16.

Notes on Two-Cycle Oil Engines.—By F. Duncanson, B. S. A clear and concise exposition of the principles on which the two-cycle oil engine works with a consideration of improvements whereby it may be made as advantageous as the four-cycle motor. The disadvantages of the two-cycle machine most considered are scavenging and its attendant losses, and the matter of compressing air, whether accomplished by an attached pump or independently of the engine. As for scavenging, the author attacks this problem at its weakest point, *i. e.,* where the indicator card made by a weak spring shows that the exhaust curve goes below the atmospheric line. He suggests that scavenging valves open here, thereby making less work for the air pump and reducing the necessary pressure for accomplishing this important work in a thorough manner. That this can be actually done is shown from diagrams taken from engines in operation. Another point to which attention is called is the matter of a reservoir for carrying a supply of compressed air. This should be as large as possible in order to keep up air pressure throughout the scavenging operation. In the remarks following the reading much favorable comment was offered, and suggestions that the results therein indicated were not only possible but had already begun to be obtained, showing the value and practicability of the paper. Paper and discussion 7,200 words.—*Transactions of the Institute of Marine Engineers,* January.

Note on the Screw Propeller.—By H. A. Mavor. As the author states in his introduction, "It is not here proposed to discuss any of the 'theories' of propeller action but to apply to recorded experimental results the methods of analysis which have been long in familiar use by the electrical engineer, who is accustomed to an exactitude of measurement not generally applied in other engineering practice. The method proposed is to record and compare all experimental results not under the broad generizations of 'propulsive efficiency,' but by specific reference to a standard of comparison." This standard of comparison is the efficiency of the propeller as a pump, to which its efficiency as a propulsive instrument is compared with the advantage of recognizing some of the loss as inevitable and impossible of elimination by improvement in design. The performance of the propeller as a pump is measured by a trial with the ship moored and the resulting thrust produced in the mooring line. By an ingenious analysis, forces acting and work done are resolved into so-called propulsive and impulsive efficiencies, a distinction due to the acceptance of the principle that some work would be lost with the use of even a perfect propeller. By separating total work done into useful and lost work the method is simpler than those resulting from the use of the blade theory. Wake factor and its effects are considered with the usual difficulties, but it may be said with more of satisfaction than is usually the case, because of a more direct manner of measuring useful results. 7,000 words.—*Transactions Institute Engineers and Ship builders in Scotland,* Fifty-fifth Session, 1911-1912.

The Case for Increase in Caliber of Naval Guns.—Editorial comment on the topic introduced by Count Giraldi before the First Italian Congress of Naval Architects and Mechanical Engineers. Contrary to the Count's conclusions, the editors hold that there are weighty reasons for the adoption of larger caliber guns that the 12-inch in modern battleships. The reasons given, and urged at some length, are the greater life of the gun for a given power, the increased charge of explosive possible in the larger shell, and the greater moral effect of the larger gun. From the standpoint of the naval architect there seems to be no serious disadvantage in the larger weapon even when arranged in threes in turrets, which plan is coming rapidly into favor in some quarters. 2,000 words.—*Engineering,* February 16.

Liquid Fuel as Supplied by the British Petroleum Company, Ltd.—This company has established large storage facilities for liquid fuel in all the principal ports in England, that at the Royal Albert Dock in London having a capacity of 42,000 tons. This article tabulates a list of the advantages of oil fuel over coal, especially for marine work. There are a number of photographs accompanying, showing in a graphical way the most important of these. In closing there is given drawings and a description of Kermode's patent oil burners of three different types—the hot air burner, the steam burner and the pressure-oil burner. These have been used quite extensively, and the first named especially shows a high thermal efficiency under test and a low fuel consumption for its operation. By its use 83 percent of the heat in the fuel is recovered in actual work, and less than 2 percent of the steam is used to operate it, and the water from this is recovered by condensation. 3,500 words.—*The Steamship,* December.

Shipping on the Great Lakes of America.—By Mr. A. E. Jordan. A lengthy article of general description about the shipping on the American Great Lakes. It has apparently been written by a traveler to tell his friends of the new land visited, and this is done with special regard to technical subjects. The author begins with statistics of the geography of the lakes and the facts of the great shipping thereon. The main topic of the paper is a general description of the types of steamers in use and the yards where they are built. Sizes, types of machinery, methods of building, eccentricities of design, are all touched upon, and as a whole it is an interesting commentary of the steamship situation of our inland seas. The author presents the facts which are the essential ones to an audience of marine engineers and naval architects. 6,000 words with photographs and map.—*The Marine Engineer and Naval Architect,* December.

New Ore Unloading Docks.—Vessel owners on the Great Lakes have recently come to the realization of a surplus of ships due to the recent great improvement in ore-loading docks. There have been, or soon will be, completed three new ore docks capable of handling by the most approved methods the mammoth cargoes shipped on the Great Lakes. Each of these is described more or less in detail and is accompanied by drawings and photographs which give a good idea of the size and general plans of the structures. The docks described are one at Presque Isle, Lake Superior, belonging to the Lake Superior & Ishpeming Railway Company; the dock at Two Harbors, belonging to the Duluth & Iron Range Railway Company, and the Great Northern Railway dock at Superior. This last, which was placed in commission last season, is of concrete, equipped with 151 double ore pockets with a capacity of 325 tons each, making a total storage of 98,150 tons. The dock is 1,900 feet 7½ inches long from end to end of crib. Pockets are standard width of 12 feet. This dock has made some very quick records, one vessel being loaded with 9,500 tons in 25 minutes, and eight vessels with an aggregate of 62,000 tons in six hours. 2,900 words.—*The Marine Review,* February.

The Rolling of Ships.—By Prof. J. H. Biles, LL. D. Presidential address before the Engineering Section of the B. A. A. S. A mathematical discussion of wave sequence and its results, based on the theory of Froude and compared with the results of experiments by Col. Russo, of the Italian navy.

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Up to the present time advocates of the marine oil engine have been obliged to base their claims very largely on theoretical data and information derived from isolated cases of experimental work. The general theory and principles of this method of propulsion have been thoroughly exploited and are readily available from reliable sources. The thermal efficiency of the Diesel engine is undisputed and the practicability of perfecting the mechanical details of construction of such an engine has been repeatedly demonstrated by the great number of different designs that have been so rapidly developed. That this should result in the immediate and widespread adoption of the oil engine by the shipbuilder and shipowner is not to be expected, however, without some further accurate information concerning the practical performance of such installations after continued service under all conditions of weather at sea in the hands of experienced sea-going engineers, where the reliability and actual economy of the engine will be exhaustively tested. Reliability, handiness and a small maintenance and repair bill are, in most cases, as essential to the success of marine machinery as a saving in the fuel bill and an increased earning power of the vessel.

Early installations of oil engines were confined to small craft, including a few Russian gunboats and French submarines. Detailed information from such installations was difficult to obtain, but the advent of the first oil-engined ocean liner, described in this and previous issues, affords a valuable opportunity to gain some knowledge of how the oil engine will work out in every-day practice on a comparatively large scale.

The reports so far received from this vessel indicate that the builders' claims have been substantially justified; and as the owners have immediately placed orders for further equipment of the same type, this success promises well for the future trial and adoption of the marine oil engine.

The tendency in the development of oil engines is toward simplification of the details and the perfection of the two-stroke, double-acting engine, which will probably pave the way to the building of engines of large power. In the engines already built for commercial purposes the size has not advanced beyond 300 horsepower per cylinder, while single cylinders, developing less than 150 horsepower, are more common. In the smaller installations the four-stroke engine has some distinct advantages, but larger powers have been produced with the two-stroke type of engine. In experimental work single cylinders of both the single and double-acting type have been built to develop 2000 horsepower, but so far the results have not led to the adoption of engines of such size on board ship.

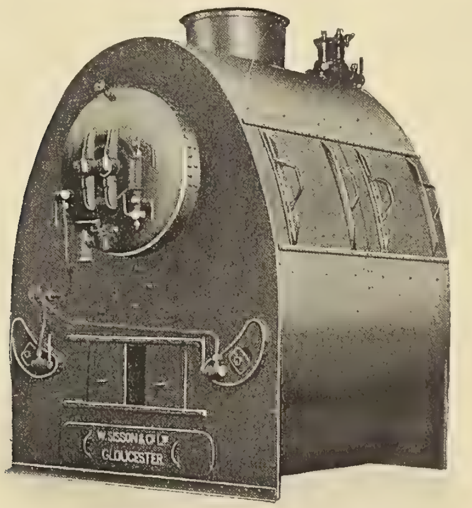
The cylinders in these large experimental engines have not exceeded 33 inches diameter, while in the smaller engines, which have been actually adopted, the diameter has been less than 25 inches. One of the obstacles that is always facing the engineer, in an attempt to increase the size of the cylinder, is the quality of material which is available for the castings. Here the metallurgist must be sought, and perhaps the growth of the marine oil engine will depend upon him as much as upon the engineer who designs the mechanism of the engine.

Along with the rapid development of the marine oil engine there has been another type of internal combustion propelling machinery that should not be lost sight of, and that is the suction gas producer plant. Although it has not been developed in such large units as the oil engine, yet it has proved a source of remarkable economy in certain types of moderate speed boats. It has the particular advantage of enabling the use, with some modifications, of the marine gasolene (petrol) engine which has been so highly perfected.

Improved Engineering Specialties for the Marine Field

The Sisson Watertube Boiler

A watertube boiler for high working pressures, which is much lighter than ordinary return tubular or other types of shell boilers, but which is still not of the proportions of the "express" type of watertube boilers, is manufactured by W. Sisson & Company, Ltd., Gloucester. These boilers, as shown by the illustration, consist of a large steam drum with two water drums connected by straight tubes. The boiler, therefore, has ample water supply and steam space, the tubes are of large diameter in relation to their length, and the arrangement is such that all parts of the heating surface can easily be examined and cleaned. No rivets or seams are exposed to the fire, or even to the waste gases. The design is such that steam can be raised quickly without damage to the boiler,



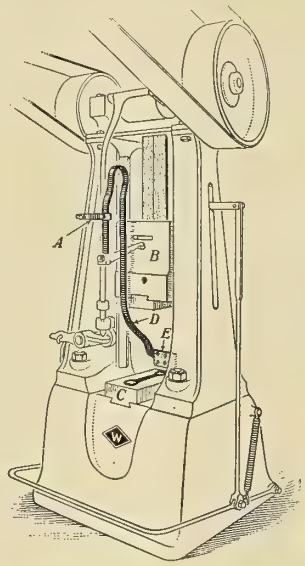
and a sudden inrush of cold air through the furnace door can have no harmful effect on the parts of the boiler exposed to the sudden change of temperature.

The steam drum, which is cylindrical, and of large diameter, is made of two plates, the upper portion being of the usual thickness required for a shell of that diameter, while the lower, which forms the tube plate, is of special thickness, but planed down along each margin to a suitable thickness for connecting to the upper plate and, at the same time, avoiding a tendency to grooving. The two longitudinal joints thus formed are lapped and triple-riveted. The ends of the drum are of dished form, pressed out with deep flanges, double riveted to the shell. The two water drums are welded tubes carefully pressed into a suitable lune-shaped cross-section, the ends being flanged or formed of solid plate single riveted to the shell. The tubes are straight, and all are of the same length, the length being so proportioned in relation to the internal diameter of the steam drum that all of the tubes can be inserted or extracted from the inside of the drum. The upper ends of the tubes in the steam drum are expanded by ordinary short expanders, while the lower ends in the water drums are expanded by a special long expander inserted from the steam drum, so that all of the tubes cannot only be inserted and withdrawn but also expanded at both ends from the inside of the steam drum.

The boiler casing is formed of mild steel plate and angles fitted with suitable non-conducting linings and baffle plates. The lower part of the casing is lined with firebrick to form the furnace. These boilers are built for working pressures up to 250 pounds per square inch.

A Useful Safety Device

The illustration shows a device made by J. H. Williams & Company, Brooklyn, N. Y., for automatically preventing accidents in drop-forging shops following the practice of supplying "precision products." Drop-forgings which require little machining are frequently furnished to gage sizes, and therefore are "restruck" in the forging dies after the "flash" or excess metal has been removed. Through some discon-



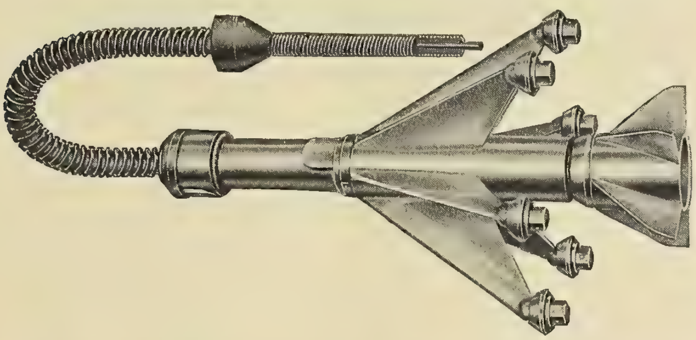
certed action the operator, when seating the forgings in the die-impression by hand, meets with serious injury from an untimely falling of the ram. To avoid such accident, the spring-steel device, shown in darker outline of the illustration, is clamped to the guide or upright at *A*. When the ram *B* descends, its contact with the device at *D* automatically forces the hand of the operator to a place of safety *C*; the leather pad *E* modifies the force of the blow to the operator's hand.

A New Log

The Maritime Instrument Company of Boston, Mass., is preparing to put on the market a new log mechanism, which they claim embodies many advantages not to be found in any system now in use. Extensive experiments and tests have been conducted during a period of four years, and before deciding to offer the apparatus for sale the company has subjected it to 50,000 miles of actual service without a breakdown or any appreciable signs of wear. The equipment consists of a protected rotator, designed to be towed alongside the vessel by means of an insulated armored cable and held clear of the hull by means of a short boom, the cable thence running through the hull of the vessel near the main deck just below the bridge and being connected to an instrument located in the pilot-house or in any other desirable location. The resistance of the actuator to the water is about the same as that of a taffrail log. This actuator, which normally runs under 6 to 10 feet of water, will under ordinary conditions be held by the boom several feet away from the hull of the ship; but in order that the rotator may not be injured by striking the side of the ship or fouled by floating matter, such

as seaweed, ice or drift wood, it is protected by a number of fin-shaped arms with rollers at the ends. These arms are thin and attach to the main body (which does not rotate), and slope back in such a way as to resist any interference. The actuator contains a watertight compartment, in which is a circuit-breaking mechanism. One contact is made in this chamber to each 150 turns of the rotator, and this represents one-tenth of a mile of travel. This contact is transmitted from the submerged mechanism through a government standard insulated and armored cable of tensile strength of about 1,500 pounds to the instrument in the pilot-house.

The pilot-house instrument in its simplest form consists of a bronze case containing magnets and a five-number total-mileage counter and light; the number to the extreme right representing tenths of miles and the four numbers to

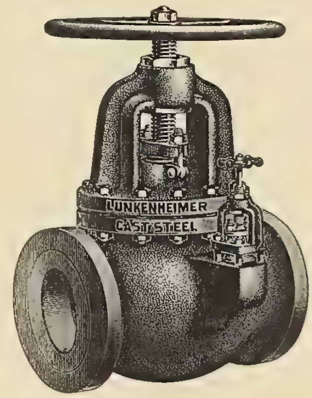


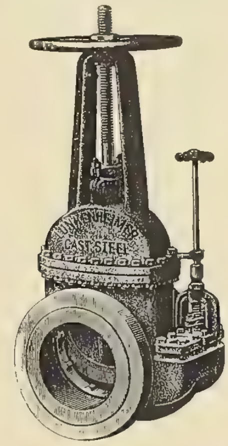
the left the total miles traveled. It is so arranged that all numbers may be set back to zero at any time desired. A more elaborate pilot-house instrument can be used if desired, which, in addition to showing the total miles traveled, will indicate by pointer and dial the rate of speed at which the ship is traveling and keep a record chart showing the speed made at any particular minute. The third part of the system is simply a small storage battery or set of dry cells, to furnish electric current for charging magnets in the pilot-house instrument.

This log is claimed to be more accurate than the logs in common use, as it is operated from the side of the vessel where it is not affected by the wake of the ship; and as it runs always in deep water, it can be run anywhere the ship travels, from dock to dock if desired. The log readings are shown in the pilot-house, thus avoiding the inconvenience of sending to the taffrail. It is claimed that the log will not become entangled in seaweed or other floating matters, a difficulty to which existing logs are subject—a most important feature in tropical waters. There is no need of taking in the cable and rotator when the ship stops at sea, as it is impossible for them to come in contact with the propeller, and the log cannot be fouled by boats passing close to the stern, for the actuator is well forward of the stern, and it cannot be tampered with by meddlesome persons.

Lunkenheimer Cast Steel Valves

Superheat and high-steam pressures have created a demand for valves of greater strength and durability than those made of cast iron. The Lunkenheimer Company, Cincinnati, Ohio, have designed a complete line of globe, angle, cross, gate, check and non-return boiler-stop valves made of cast steel for service where high pressures and superheat are used. With the exception of the largest sizes, the Lunkenheimer cast steel valves are made of crucible steel and not open hearth or converted steel. Crucible steel is made and melted in closed crucibles, out of all exposure to furnace gases, and solid castings free from blow-holes are thereby insured. This is not true of the open hearth and converter steels, the first of which is heated by blowing hot gases over the molten metal, and the second by blowing them sometimes through the metal. Aside from forming blow-holes these gases form oxides, which dissolve in the steel and thereby reduce its ductility and cause a low elastic limit. All of Lunkenheimer cast steel valves are annealed, which, it is claimed, relieves all internal stresses and makes a fine crystalline stucture, which is very essential to strong steel. The valves are made to meet the specifications of the American Society for Testing Materials, and it is claimed they contain less than .05 percent of either



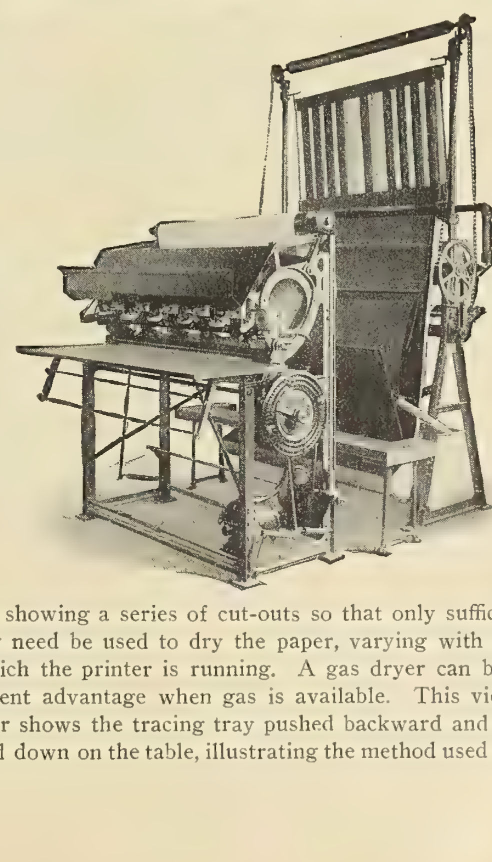


phosphorus or sulphur. The tensile strength of Lunkenheimer cast steel is about 80,000 pounds per square inch, with a safe elastic limit and excellent elongation.

For various pressures and degrees of superheat and to meet the requirements of engineers who differ as to the material used, Lunkenheimer cast steel valves are made in two combinations of material as regards the trimmings. For lower pressures and degrees of superheat the company manufactures a large and complete line of cast iron and "puddled" semi-steel valves.

A Continuous Automatic Electric Blue Print Equipment

The C. F. Pease Company, of Chicago, Ill., recently placed on the market a continuous automatic electric blue print equipment under the trade name of "Peerless." The illustration represents the Peerless equipment arranged with an electric



dryer showing a series of cut-outs so that only sufficient electricity need be used to dry the paper, varying with the speed at which the printer is running. A gas dryer can be used to excellent advantage when gas is available. This view of the printer shows the tracing tray pushed backward and one lamp turned down on the table, illustrating the method used for clean-

ing the globes and trimming the carbons. The apparatus not only prints, washes and dries the paper by one continuous operation, delivering the finished prints at the end of the dryer automatically wound up in a loose roll ready for use, but it also returns the tracings automatically to the operator as he stands in front of the machine. It is claimed that the operator is able to do 25 to 33 1/3 percent more printing than with other machines, while the washing and drying apparatus more than doubles the output. In other words, with one of these complete equipments it is possible for a large user to cut the cost of his blue printing bills in half.

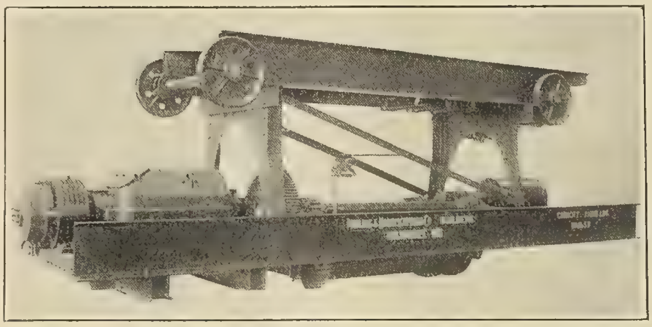
Another very interesting feature of the machine is that the exposure can be immediately seen, and the speed of the machine increased or decreased instantly by means of the electric speed control at the right hand of the operator. The speed being controlled directly through the motor, all belts and unreliable friction disks are dispensed with, and in the case of a varied load on the line the speed of the printer varies with the lamps, thus preventing the spoiling of the prints. The apparatus is very compact, requiring a floor space only 5½ by 6½ feet, and with it it is possible for one operator to deliver up to 100 yards finished blue prints per hour, depending on the speed of the paper and the character of the tracings. There are no expensive glass cylinders or transparent bands requiring replacement. The printing surface is a segment of heavy plate glass mounted in an iron frame, and so hung that there is no posibility of breakage and the cost of maintenance has practically been eliminated. A better quality of blue prints is also claimed, as it is possible to obtain a very close exposture, and by the method of washing only the printed side of the sheet and drying uniformly the entire width the prints are delivered in the rewinder perfectly free from wrinkles or distortions, and where a high grade of paper is used it is possible to produce them without shrinkage.

FREIGHT-HANDLING APPLIANCES AT THE TEXAS CITY WHARVES

High-Speed Trolleys for Handling Miscellaneous Freight

The Texas City Transportation Company, Texas City, Tex., maintains huge warehouses where a miscellaneous assortment of material, from bales of cotton to pig iron, is constantly being received or shipped. To handle this material rapidly and economically the Pawling & Harnischfeger Company, Milwaukee, Wis., designed and built the high-speed trolleys illustrated.

These trolleys are of the man-riding type; that is, they carry a cage for the operator. The trolley travel speed is about 700 feet per minute, and the hoisting speed, with a 5-ton load, 250 feet per minute. One of the special features of the hoisting mechanism is the arrangement of parts for taking the hook off of the hoisting rope and slipping the same



PAWLING & HARNISCHFEGER HIGH-SPEED TROLLEY

hoisting rope into a single-rope grab bucket of the latch open type. Rope guards on the bucket are arranged in such way that they can readily be opened, and the hoisting rope, which also performs the functions of the closing line of the bucket, readily inserted. A novel feature in the application of a single-line bucket of this type is to use it with a set of holding lines as used on a two-line bucket. This holding line is wound upon a drum operated by a motor just big enough to keep the slack out of the rope, either going up or down. In this way it is possible to discharge the bucket at any desired height by means of a large foot-operated band brake on the holding drum. When the bucket is fully open, and therefore latched, the foot brake is released, and the weight of the empty bucket is again placed on the closing line, when it can be lowered without closing until it strikes the stock pile. This design was worked out in this manner in order to concentrate all the motor capacity of the hoist motor on the one drum

which is used for the hook service as well. When the bucket is not in use the holding line is disconnected from the bucket and wound up on its drum, which then remains at rest. The holding-drum motor performs about the same function as the spring in a curtain roller; that is to say, it tends to run ahead of the hoist motor when going up and to lag behind the latter when going down. In this way the holding line is never slack, and it is therefore impossible to jerk the line when the bucket is discharged.

In connection with the hook service a lifting magnet of 2½ tons capacity is used. The feed cables for this magnet are wound up and paid out by a small motor-operated winding drum. The performance of this cable take-up is exactly the same as the holding-drum mechanism; that is, the cable is always under slight tension going either up or down.

The trolley is of the inside-running type, and is operated on a plate girder cantilever arm, which can be moved longitudinally over the boat to an extent of about 60 feet beyond the face of the dock. The reason for this peculiar construction lies in the fact that it is impossible to move a hinged apron of the ordinary construction through the rigging of large sailing vessels, such as these unloading machines frequently have to serve, either loading or unloading, the great extension of the cantilever being necessary in order to load or unload lighters tied up on the outside of the big vessel.

A 100-horsepower mill type motor is used for hoisting and a 35-horsepower railway type motor with a foot brake for travel. The hoist controller is of the magnetic switch-operated type with a motor controller, dynamic braking. The load is sustained by a disk motor brake of unusually large proportions and of a new design which will permit of the instant adjustment of the air gap.

Improved Sterling Lubricators

For efficient cylinder and valve lubrication it is necessary to maintain a lubricating film over the rubbing surfaces, and when once this film is established to feed to these surfaces at frequent intervals just sufficient oil to replace that which is working on through to the exhaust. To accomplish this four things must be considered: the moisture in the steam, the proper location of oil feeds, quality of oil and the manner of feeding the oil. The improved Sterling lubricator, manufactured by the Sterling Machine Company, Norwich, Conn., has been designed to meet these conditions.

A substantial tank is provided, through which is cast a hollow hub containing the main operating shaft, driven by a connecting rod attached to some reciprocating part of the unit to be lubricated. The lever is held by a wing nut, and may be moved in and out, thereby varying the amount of rocking motion of the piece which is termed the driving hub. This hub, by means of hardened pawls, drives the hardened drop-forged ratchet, which is held from moving in but one direction by back-lash pawls working in reamed holes in the main tank casting. The ratchet is pinned to the main shaft, which carries at one end a strong hand crank and at the other end a broad-face steel cam operating the yoke. This yoke has a large hollow shank working in a reamed hole in the main casting. The hollow shank is filled with oil, and contains a felt wick for lubricating the cam. This yoke, as it rises and falls with the cam action, carries with it the pumping plungers, the adjustment and action of which are self-evident. The various parts of the device are easily accessible and can be easily removed and examined. The valves of the pumps are of the steel ball type. Each pump has two suction and four delivery valves. A positive-acting check valve has been carefully designed and a reliable oil-feed indicator is provided if desired.

Technical Publications

The Mechanical World Pocket Diary and Year Book for 1912. Size, 4 by 6 inches. Pages, 426. Illustrations, over 100. London, 1912: Emmott & Company, Ltd. Price, cloth, 8½d.; leather, 1s. 8½d.

This is the twenty-fifth year of publication of this book and, as is the custom, parts of it have been revised and some additions made to bring the book up to date. It is essentially a mechanical engineers' pocketbook, containing a vast amount of useful information expressed in concise form with the aid of tables and diagrams. The section on steam turbines has been partly rewritten and extended since the last volume was issued. New sections on indexing on the milling machine, on verniers and micrometers, and on gaging cylindrical bores have been added, together with sections dealing with roller bearings, helical springs, cutters for milling spiral gears, speed calculations, etc. New tables of weights and proportions of rivets, helix angles, areas of circles in square feet and a millimeters-to-inches conversion table have been introduced.

The Mechanical World Electrical Pocketbook for 1912. Size, 4 by 6 inches. Pages, 290. Illustrations, 80. London, 1912: Emmott & Company, Ltd. Price, 8d.

This book is a companion volume to the one above reviewed. It contains a collection of electrical engineering notes, rules, tables and data. The book is published annually, and the present volume has been enlarged by the addition of sixteen pages. The matter devoted to lighting has been entirely rewritten, and new sections on motor starters, static transformers and the construction, rating and testing of high-tension apparatus have been added.

Experimental Engineering. By U. T. Holmes, Commander, U. S. N. Size, 5¾ by 9¼ inches. Pages, 311. Illustrations, 152. Annapolis, Md., 1911: United States Naval Institute. Price, $2.50.

A previous volume, called "Notes on Experimental Engineering," was published by this author in 1907. This book, therefore, is a revision of the former work, to which has been added much new matter, together with a complete revision of the whole book. Much of the information has been taken from other text-books, but, as a whole, it represents in a clear manner a very important branch of the engineering profession. The means of testing materials and appliances employed in engineering work, with descriptions of the instruments and methods of procedure, are given in very complete form. The book would be very useful to either students or practicing engineers who are devoted to other work besides marine engineering.

The Testing of Motive Power Engines. By R. Royds. Size, 5¾ by 8¾ inches. Pages, 396. Illustrations, 193. New York and London, 1911: Longmans, Green & Company. Price, 9s. net.

In the preface the author states that this book is intended for engineering students who have already acquired an elementary knowledge of motive engineering, and who desire information on the practical testing of motive power engines. In other words, the information given is supplementary to the work which is carried out in the laboratories of technical schools. It covers the work which is usually encountered in actual engineering practice and deals with the methods in common use. After going into the general principles concerning motive power engines, the measurement of pressure, temperature, horsepower, etc., different types of engines, including locomotives, motor cars, reciprocating steam engines, steam turbines, internal-combustion engines, gas producers, steam boilers and auxiliary machinery, such as condensing apparatus and pumps, are discussed in detail. The final chapters deal with refrigeration tests, air compressors, air motors, fans, blowers, water turbines and pumps.

The Navy League Annual. Edited by Alan H. Burgoyne. Size, 5½ by 8½ inches. Pages, 341. Numerous illustrations. London, 1912: John Murray. Price, 2s. 6d. net.

As this is the fifth year of publication of this Annual, doubtless many of our readers are familiar with its general purpose. The book is divided into three parts. The first takes up the progress of British and foreign navies; the second contains a series of articles by special writers on a great variety of subjects relating to naval matters, and the third contains a list of ships and comparative statistics, together with dock and ordnance tables. The editor points out that naval progress during the past twelve months has been regular and sustained, there being no remarkable innovation as was the case last year. Ships mounting 13.5-inch guns are now building. Ships mounting 16-inch guns have been designed. A speed of 30 knots or more has been attained by immense armor clads, while submarines mounting guns are approaching completion. These are noteworthy facts, yet they follow the natural cycle of development and do not present any innovations such as were chronicled in the previous year.

Personal

George Shepard, chief engineer of the marine department of the Maryland Steel Company, Sparrows Point, Md., has been appointed chief engineer of the American-Hawaiian Steamship Company, New York.

A. L. Hopkins, works manager of the Newport News Shipbuilding Company, Newport News, Va., has been elected vice-president of this company, in charge of the New York office, and H. L. Ferguson, formerly superintendent, has been made general manager of the company.

Obituary

Henry Wilsin Spangler, M. S., Sc. D., Whitney professor of dynamical engineering University of Pennsylvania, Philadelphia, died Sunday, March 17.

Prof. Philip R. Alger, a member of the Special Ordnance Board of the United States Navy Department, and for many years editor of the *United States Naval Institute Proceedings*, died at Annapolis, Md., Feb. 23. Prof. Alger was born in Boston Sept. 29, 1859, and graduated from the Naval Academy in 1880. In 1890 he was appointed professor of mathematics in the navy with the rank of lieutenant, and later was promoted to the equivalent rank of captain. Prof. Alger's books on ordnance and applied mechanics are considered standard works, and are used as text books at the Naval Academy.

Naval Constructor Robert W. Steel, retired, died at Spring Lake, N. J., Feb. 29. He was born in Ireland in 1831, and was appointed master shipwright at the New York Navy Yard early in 1861. Throughout the Civil War he was assistant to the naval constructor at that yard, and in May, 1871, he was appointed an assistant naval constructor and ordered to the Philadelphia yard, where in 1875 he was promoted to the rank of naval constructor and later served at various yards, retiring in 1893 on account of age.

William McAllister, a retired yacht builder of City Island, New York, died of heart disease at Washington, D. C., March 24. During the Civil War he was at the shipyard of Mr. William H. Webb in New York, and there was employed in the construction of many of the gunboats built for the Federal Government. He was subsequently employed in the construction of many famous yachts. He is survived by a widow, two daughters and one son, Mr. Charles A. McAllister, engineer-in-chief of the Revenue Cutter Service.

Rear Admiral George Wallace Melville, U. S. N., retired, prominent in Arctic exploration and naval engineering, died at his home in Philadelphia, March 17. Admiral Melville was born in New York City in 1841. He was educated in the New York public schools and the Brooklyn Polytechnic Institute. Later he became associated with the engineering works of James Binn in Brooklyn.

At the outbreak of the Civil War he became a third assistant engineer in the United States navy, and served with signal ability on board various vessels. At the close of the Civil War he continued his service on various vessels and in navy yards until in 1879 he went to the Arctic from San Francisco with Lieut. George W. De Long on the *Jeanette* expedition. He was one of the few survivors of that hazardous expedition, and his exploits brought him international fame.

A few years later Mr. Melville returned to the Arctic on another expedition, and recovered not only the records of the *Jeanette* expedition but the bodies of Lieut. De Long and his companions. In appreciation of his bravery on this expedition he was advanced fifteen numbers in rank in the navy and a gold medal was struck for him by special act of Congress.

In August, 1887, he was appointed chief engineer of the navy, a position which he held for sixteen years, during which time he was responsible for the designs of the machinery for 120 warships with an aggregate horsepower of 700,000. Rear Admiral Melville was the first engineer-in-chief to use water-tube boilers in large war vessels, and he was the first naval engineer to secure accurate data upon the coal consumption of boilers on forced draft trials. His stand against the reduction of boiler weights at the time of the extensive use of forced draft was a pronounced achievement. Two of Melville's greatest successes were the perfecting of triple-screw machinery arrangement which made the *Minneapolis* and *Columbia* the speediest vessels in the navy at that period, and the introduction of the method of standardizing screws as a method of determining speed trials. It was to him also that the United States navy owed the first high-speed battleships—the *Maine*, *Missouri* and *Ohio*. Other achievements in his naval career include the repair ship and distilling ship which he fitted out during the Spanish war.

After his retirement from naval service in 1903 Rear Admiral Melville took an active interest in Arctic exploration and engineering progress, one of his latest inventions being the reduction gear which has been adapted to turbine drive in slow-speed ships. He was the recipient of many distinguished professional honors, receiving degrees from the Universities of Pennsylvania, Harvard, Columbia, Georgetown and the Stevens Institute. He was past-president of the American Society of Mechanical Engineers and the American Society of Naval Engineers. He was also a member of the Society of Naval Architects and Marine Engineers, an honorary member of the Institution of Naval Architects, an honorary member of the Royal Swedish Society of Anthropology, a member of the National Geographical Society, the Geographical Society of Philadelphia, the Naval Order of the United States and the Military Order of the Loyal Legion. He was also received in private audience by the Czar and Czarina of Russia, and decorated with the Order of St. Stanislaus of the First Class.

Burial of the Maine

The final sinking of the wreck of the United States battleship *Maine* occurred on March 16 off the coast of Cuba. Not only was the burial ceremony carried out in a manner befitting one of the most impressive events in the history of the United States navy but the occasion was fittingly recognized throughout the country in whose defense the *Maine* was lost. The raising of the *Maine* from Havana harbor was one of the most unusual and difficult engineering feats ever accomplished by the Engineering Corps of the army, and the successful completion of this task reflects great credit on those who had it in charge.

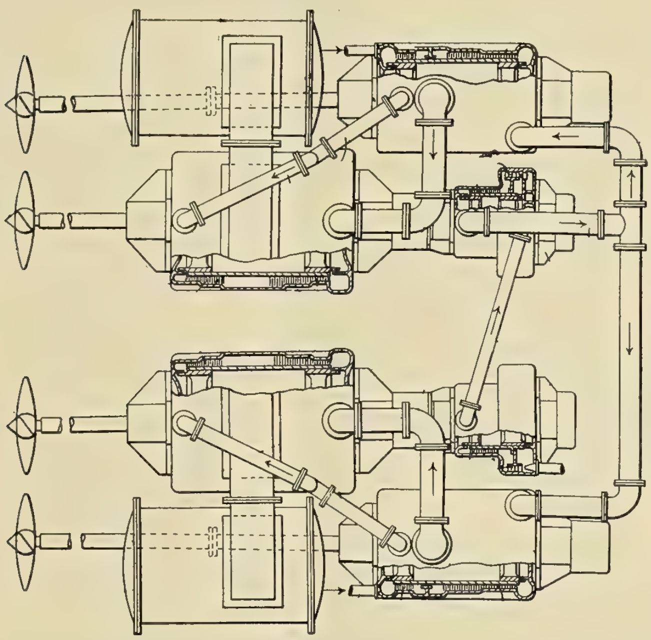
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,009,784. MARINE TURBINE INSTALLATION. CHARLES ALGERNON PARSONS, OF NEWCASTLE-UPON-TYNE.

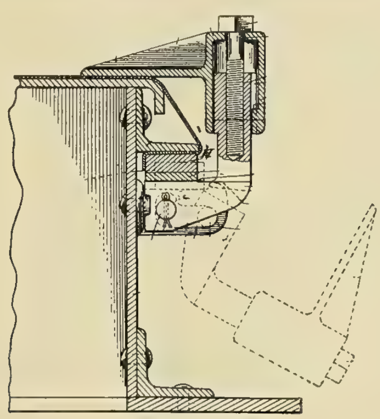
Claim 2.—In a marine turbine installation having high and low-pressure turbine elements, impulse turbine parts followed by reaction parts



constituting at least two of the high-pressure elements which are connected in series with one another, the impulse parts thus alternating with the reaction parts. Eleven claims.

1,008,146. HATCH-COVER FASTENER. HORATIO N. HERRIMAN, OF CLEVELAND, OHIO.

Claim 2.—In a hatch-cover fastener, the combination with a fastening member comprising an element pivotally mounted upon the hatch combing, a second element slidably mounted on said first-named element and adapted to project over the hatch opening, and means adapted to draw said two elements toward each other; of an abutment fixed to said combing



and projecting therefrom above the pivotal axis of said member; said pivotal element and abutment forming a seat for the batten. Four claims.

1,008,953. SHIP'S PROPELLER. FRANK CLENNELL, OF WELLINGTON, AND FREDERICK WILLIAM THORPE, OF MOTUEKA, NEW ZEALAND.

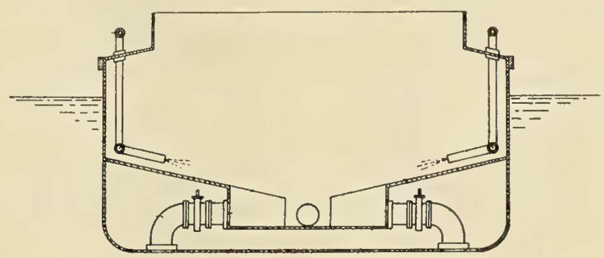
Claim.—In a ship's propeller, the combination of a tail-shaft having a tapering end portion, a threaded outer end, and an axial bore therethrough; an inner boss-piece having a tapering opening therethrough fitting on said tapering end portion, and provided with outer recesses forming apertured flange portions; an outer boss piece provided with outer recesses forming apertured flange portions and an end bearing-recess; bolts in the apertures of the flange portions and holding the inner and outer boss-pieces together, whereby a substantially spherical boss is formed, said pieces being provided with hollow spaces and supplementary co-operative recesses forming radial bearings having annular recesses, the inner boss-piece also being provided with step bearings having closed inner ends and coaxial with the radial bearings respectively; shanks fitted in said radial bearings and the corresponding step bearings respectively; propeller blades on said shanks; bevel gears on said shanks and movable in said spaces; a spindle in said axial-bore and having its end seated in said bearing recess of the outer boss piece; a bevel gear on said spindle and meshing with the bevel gears of the shanks; means for adjusting said spindle relative to the tail shaft; a packing gland on the outer end of the tail-shaft and embracing said spindle; flanges on said shanks and seated in said annular recesses, and a nut on said threaded portion of the tail shaft and holding the inner boss piece in position.

1,008,235. BILGE PUMP. GEORGE EDWARD BADGER, OF MAYGER, OREGON.

Claim 1.—In a bilge pump, a chamber, blades mounted therein, there being inlet and outlet ports in the chamber, means for driving the blades, a chamber in communication with the first-named chamber at one of the ports, and two radially disposed wings spaced apart and secured together adapted to rotate in the chamber. Ten claims.

1,012,196. APPARATUS FOR DISCHARGING DRELGE-HOPPERS AND THE LIKE. OTTO FRÜHLING, OF BRUNSWICK, GERMANY.

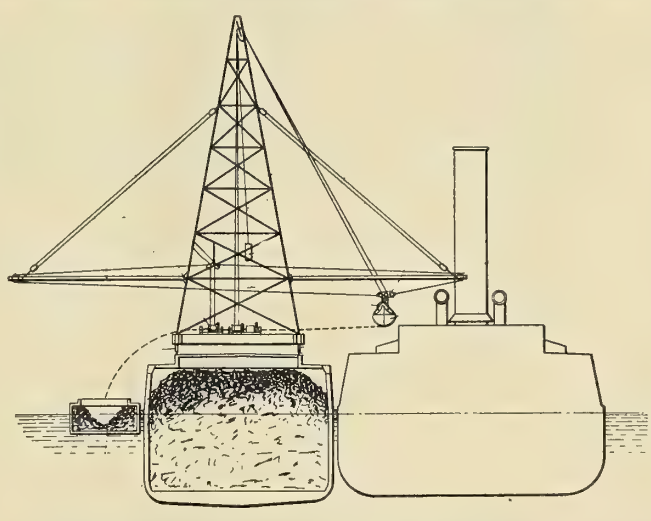
Claim 1.—In a device for discharging dredge hoppers and the like, a hopper for dredged material, a conduit opening laterally from the hopper near its bottom into the external water simultaneously introducing water



into the hopper and discharging material diluted by said water, and aprons adjacent to the lateral opening, keeping a space adjacent the lateral opening in the hopper free from dredged material. Four claims.

1,013,420. APPARATUS FOR TRANSFERRING MATERIALS. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

Claim 2.—The combination of a support, a load carrier, a hoisting rope therefor, a hoisting rope actuator, an elevated hoisting rope sheave,



an elevated hoisting rope swinger frame, a pendulum rope for supporting said swinger frame, a weight constituting a take-up for said pendulum rope, and swinger ropes connected with said swinger frame and extending in opposite directions from said hoisting rope. Twenty claims.

1,009,753. LIFE-BOAT-HANDLING APPARATUS. ROBERT HUNTINGTON, OF BOSTON, MASS.

Claim 1.—A life-boat-handling apparatus comprising davits mounted to swing over the side of the vessel, a cradle for supporting the boat on the deck of the vessel with the keel of the boat on the inboard side of its point of suspension from the davits, tackle for lowering the boat and for swinging the davits, and means located within the boat for entirely controlling the said tackle to lower the boat and swing the davits. Thirteen claims.

1,009,758. BOAT LAUNCHING AND STOWING APPARATUS. ANTHONY J. LEWKOWICZ, OF NEW YORK, N. Y., ASSIGNOR TO THE MARTIN MARINE LIFE SAVING DEVICES, LIMITED, OF TORONTO, CANADA, A CORPORATION.

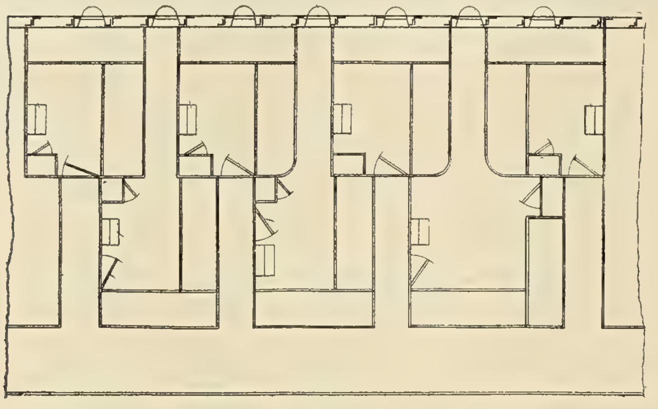
Claim 3.—In a boat-launching apparatus, the combination of a crane, a cam-shaped trackway higher at its outboard than at its inboard end, and movable supporting connections comprising track engaging and thrust

rollers between said crane and trackway so disposed as to cause the extreme end of said crane to revolve around a movable center to move at different angular velocities while moving over equal arcs of said trackway. Twenty-one claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C. London.

10,946. CONSTRUCTION AND DISPOSITION OF STATEROOMS ON PASSENGER SHIPS. BARON INCHCAPE, OF STRATHNAVER, G. C. M. G., K. C. S. I., K. C. I. E., London.

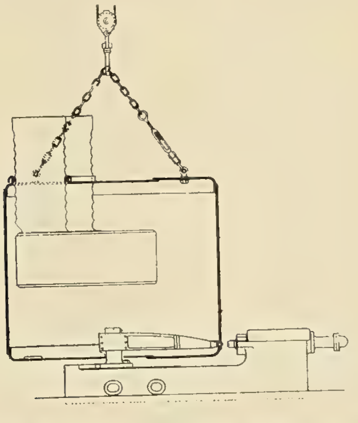
This invention has for its object to give inside staterooms access to the ship's side and more efficient light and ventilation than hitherto. Adjacent outside rooms, that is, the rooms abutting on the ship's side, are separated by a passage provided with a sidelight. The inside rooms



are so arranged with respect to the outside rooms that each passage leads to the middle of an inside room. The rooms have doorways leading into athwartship passages between the inner rooms; the outter rooms have doorways in the outter ends of these passages, and the inner rooms doorways in the sides.

24,208. RIVETING MARINE ROLLERS. W. B. THOMPSON, DUNDEE.

Hitherto, in marine boilers the ends of which have the flanges turned inward, the rear end only has been machine riveted. By the new method, the fore end is first riveted, then the fire-box pushed through its



opening in the fore end from within and suspended with the attached combustion chamber by means of wedges, so that room is left for operating the riveter on the rear-end flange.

27,144. SUBMARINE AUDIBLE TELEGRAPHY AND SIGNALING. DR. J. KLUPATHY AND BERGER.

This invention relates to a transmitting device comprising apparatus in which a ship's body or other floating object is connected with a vibrating system of strings or rods adapted to oscillate and stretched between the walls of the ship; or rods fixed in the center and caused to vibrate, the oscillations being communicated to the water by the body, acting as a soundboard. The string may be, for instance, excited by the rotation of a friction wheel covered with cloth, silk, etc. The sound continues as long as the wheel is rotating or the string touched and vibrated. Morse signals can thus be produced by damping the string between signals.

17,596. SIGNALING BY WATER SIRENS. NEUFELDT & KUHNKE, KIEL.

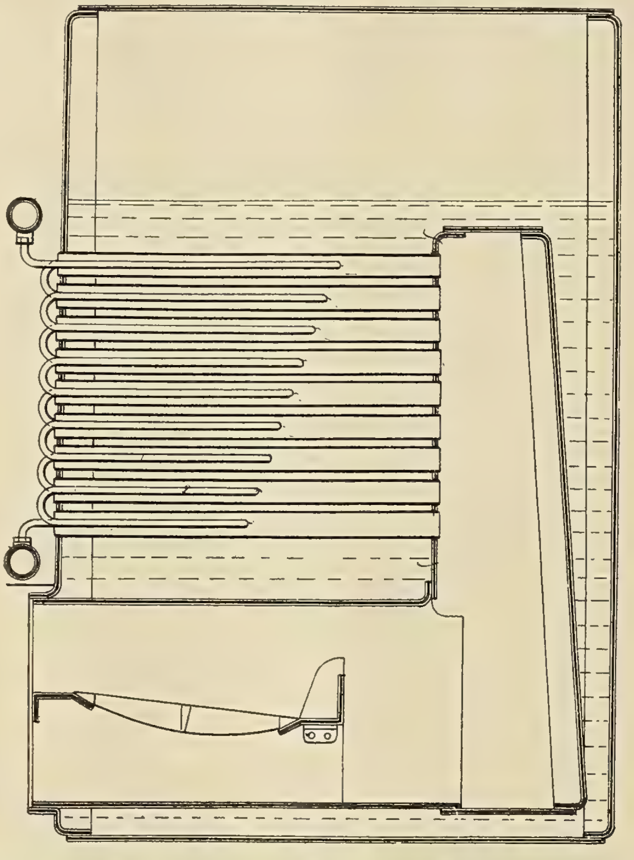
In order to secure a uniform speed for electrical motors used in driving these sirens, the lever, by which such a siren is opened or closed, also simultaneously makes or breaks, respectively, an electrical contact in the motor circuit so that the current, when the siren is closed, traverses a resistance equivalent to the load imposed by the siren when at work. By this arrangement the note pitch of the siren is not affected by variations in speed.

20,908. ASH EJECTORS. SOC. ANON DES. ETAB. DELAUNAY-BELLEVILLE, ST. DENIS.

This apparatus is characterized by an archimedean screw which rotates at a slow, uniform speed and receives from a hopper, located above, the cinders and clinker, and conveys them to the neck of an ejection nozzle supplied with water by a pump at high pressure.

13,317. SUPERHEATERS FOR MARINE BOILERS. O. E. JÖRGENSEN, COPENHAGEN.

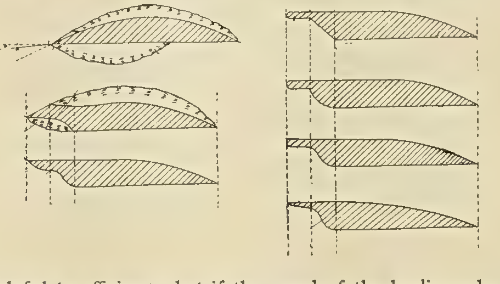
With smoke-tube superheaters it has been found that the lower row of smoke-tubes is easily choked, thus impeding the draught and rendering these superheating elements ineffective. By this invention this draw-



back is alleviated in that the obstruction in the lowermost smoke-tubes, by the superheating elements, is relatively decreased by making the length of the superheating tubes (the long U-shaped tubes) different, and arranging the shortest in the lowermost and the longest in the uppermost smoke-tubes.

28,894. SCREW PROPELLERS. W. H. WHITE, K. C. B., FROM D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. NAVY.

In order to minimize the harmful effect of cavitation on the efficiency of high-speed propellers, this invention consists in giving the following portion of the blade face a setback with reference to the leading portion, so reducing the area of the blade face covered by cavities generated by the action of the leading portion. The formation of cavities over the



back is helpful to efficiency, but if the speed of the leading edge of the blades becomes so great that cavities extend over a large proportion of the blade face the efficiency of the propeller is reduced. The first figure shows the effect of cavitation on the ordinary blade, and the second figure, the new shape and its cavitation. The others are modified forms.

26,036. CONSTRUCTION OF SHIPS AND DESIGN. A. E. BERESFORD, GOOLE.

Relates to an alteration in the form of ships' bottoms. These are corrugated fore and aft. This construction affords greater longitudinal strength than plating not corrugated. The floors, cut to suit, have a firmer foundation and cannot "trip." Intercostals and longitudinal girders between floors are obviated. The corrugations act as wash plates and retard the force of water-ballast transversely in double bottom steamers. Among other advantages, the reduction of rolling is claimed.

International Marine Engineering

MAY, 1912

The French Bucket Dredger Bassure de Baas

The bucket dredger *Bassure de Baas*, illustrated on this page, has been built this year by the Société des Ateliers et Chantiers de France, Dunkerque, for the French administration of Ponts et Chaussées at Boulogne, and to plans approved by Monsieur Delmotte, engineer to the Ponts et Chaussées, whose extensive knowledge of dredging operations and of the special requirements of that port were invaluable to the builders in preparing the plans. She is one of the most powerful dredgers built for this department, and has been specially designed for dredging in very hard grounds. To this end every part of her structure has been very strongly built, and special attention has been paid to the withstanding of the enormous shocks met with from time to time. The general dimensions are as follows:

Length over all	206 feet.
Length on waterline	189 feet.
Breadth, molded	38 feet.
Depth, molded	15 feet.
Speed (loaded with 650 tons of material)	6½ knots.
Output per hour from a depth of 26 feet below the waterline	10,000 cubic feet.
Maximum depth of dredging (with the bucket-ladder at an angle of 45 degrees).	60 feet.

The center portion of the vessel is a hopper of 10,000 cubic feet capacity, the doors of which are opened and closed by means of a powerful steam winch situated amidships. An arrangement is fitted which permits of the doors being opened either all at once or singly, should it be necessary. Shoots are arranged, fitted with big gate valves, enabling the vessel to discharge the dredged matter into her own hoppers or into hopper barges at either side. These gate valves are built of steel and thickly armored with elm, each having a special steam winch for its opening and closing. The hull has been built of Siemens-Martin steel, the scantlings being considerably stronger than those required by the Bureau Veritas for this type of vessel. The riveting of the hull, main framing and bucket ladder has been, where possible, done by hydraulic power.

A strongly-built raised forecastle ties the two sides of the vessel above the ladder well, and carries the blocks supporting the weight of the bucket ladder. The hull is divided into eighteen watertight compartments by means of longitudinal and transverse bulkheads, in order to ensure a good margin of buoyancy in case of collision.

A comfortable accommodation for captain, engineers and crew is provided under deck, and a luxurious office is provided for the superintendent and placed abaft the engine room. Ventilation and light are abundantly supplied, and a continuous service at sea is easily possible. A complete electric and oil-light installation is fitted throughout, four arc lights being fitted on deck to permit of working at night. A well-fitted smithy and workshop is placed under the forecastle head. The storerooms are large, as necessitated on this type of vessel.

FIG. 1.—FRENCH BUCKET DREDGER BASSURE DE BAAS

The vessel is propelled by twin-screws, driven by two compound, surface-condensing engines. These engines are also used singly for driving the dredging apparatus, being connected and disconnected by means of direct clutches. Their principal dimensions are as follows:

High-pressure cylinder	16 inches.
Low-pressure cylinder	32 inches.
Stroke	24 inches.
Revolutions per minute	120
Total indicated horsepower	750

Steam is supplied from two Scotch boilers of 14 feet diameter and 11 feet length, working at a pressure of 130 pounds per square inch. A "Field" type donkey boiler supplies the auxiliary machinery, heating, dynamo, etc., while in port.

The coal bunkers and feed-water tanks are large enough to permit of 70 hours' continuous steaming at full speed.

The auxiliary engines for maneuvering the vessel consist of powerful twin-cylinder steam winches placed at the bow and stern for regulating the mooring chains during dredging operations and also serving as windlasses. The forward winch, which extends the full width of the vessel, develops 110 indicated horsepower, and comprises six barrels and 2 gypsy-wheels. The after winch is somewhat smaller, developing 50 indicated horsepower, but possesses the same complement of barrels and gypsy-wheels. It is also arranged to gear up with the chain of buckets so as to enable it to be turned in time of repairs.

A steam crane, lifting 8 tons at a radius of 29 feet, is placed on the forecastle head to facilitate the repairs to the chain of buckets, and also for the removal of the heavy stones occasionally brought up, which, if allowed to fall into the hoppers, would probably go right through the bottom. It was not long ago that a piece of rock weighing 6 tons was brought up by a dredger in Boulogne harbor, and stones of about 1 ton are a common occurrence when dredging in the hard ground.

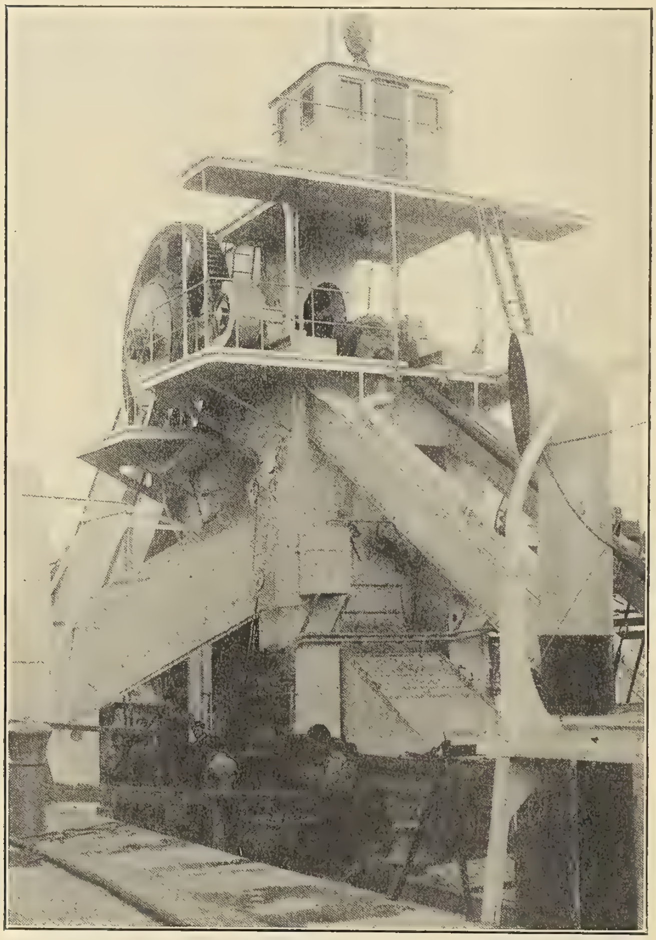


FIG. 2.—VIEW SHOWING FRICTION CLUTCH ON BUCKET DRIVE

The hoisting and lowering gear for the bucket ladder consists of heavy four-fold blocks, rove with a flexible steel wire rope of 5½ inches circumference. This rope is wound round a drum driven by a double worm gear, actuated by a special winch situated under the deck. This winch is twin-cylinder, and develops 190 indicated horsepower. It is maneuvered from the deck, under the control of the chief dredger. By this means the bucket ladder can be raised or lowered at will and at a speed of 5 feet 3 inches per minute.

The dredging apparatus, as above mentioned, is driven by one main engine at a time, the power being transmitted by very heavy cast steel gear wheels. A transmission room is placed between the stokehold and the engine room, where there are two different multiplications of gear, used according to the nature of the ground dredged. From the transmission room the power is transmitted by an inclined shaft actuating by more heavy cast steel pinions and bevel wheels the tumbler prism driving the chain of buckets.

A great feature of the drive is an enormous friction clutch on the upper tumbler prism shaft, which can be regulated so as to slip whenever the buckets come into contact with something abnormally resistant, thus diminishing the heavy shocks due to encountering big pieces of rock, etc. This clutch, which is the invention of Mr. Boyd, managing director of the builder's firm, is clearly shown in Fig. 2, a most useful point being that it can be regulated with the machinery in motion, thus permitting the regulation to be made to a nicety.

The buckets are formed of cast steel backs with hard steel plate bodies. These are surmounted with sharpened lips of special quality steel. All the riveting is hydraulic. Each bucket is of 12.5 cubic feet capacity, and there are forty in the entire chain. The buckets themselves weigh about 1½ tons each, and the forged steel links connecting them weigh ½ ton a pair. The chain of buckets is guided along the bucket ladder on cast steel rollers, of which there are fourteen. The tumbler prisms are of cast steel, easily accessible and automatically lubricated by grease under pressure. After passing the upper tumbler prism the chain of buckets passes over a guide wheel, which prevents the slack in the chain from touching the structure of the main framing when dredging in deep water.

A large double-acting pump, placed in the engine room, ejects water onto the shoots in order to facilitate the sliding of sticky materials, such as clay, etc.

The stern compartments occupied by the machinery are covered by a spacious deckhouse, in which is fitted auxiliary machinery, such as pumps, ash-hoist, steering gear, etc. The donkey boiler occupies the forward portion of this deckhouse.

The dredger, fully equipped, is completed by two lifeboats and a heavy boat, put overboard by two derricks aft, for the placing of the anchors and mooring chains. On the top of the main framing is installed a navigating bridge and a house containing steering wheel, telegraph, chart table, etc. On the top of this house is placed the standard compass.

During trials, and during the six months in which this dredger has been in service, the results have been well in excess of those demanded by the owner's specification. As much as 14,500 cubic feet has been discharged in one hour when dredging in the clay-mud, and 13,000 cubic feet has been about the average. When dredging in the rocky and stony ground naturally no average can be taken, but here also the vessel has given every satisfaction.

This firm built at the same time a similar dredger of very slightly smaller dimensions for the port of Dunkerque. In this case the hopper doors were actuated by hydraulic power, but otherwise the designs were essentially the same.

Lloyd's Register of Shipping reports that excluding warships there were 545 vessels of 1,686,898 tons gross under construction in the United Kingdom at the close of the quarter ended March 31. The tonnage now under construction is about 168,000 tons more than that which was in hand at the end of the last quarter, and exceeds by 312,000 tons the tonnage building in March, 1911. The present figures are the highest ever recorded in the society's quarterly returns. The total number of warships under construction in the United Kingdom for the British Admiralty is 54, of 319,740 tons displacement. In addition there are seven warships building for foreign governments of an aggregate displacement of 109,700 tons. The condition of shipbuilding in the United Kingdom is therefore much better than ever before in the history of the industry.

Shell Suction Dredger Used in the Dutch Shell Lime Industry

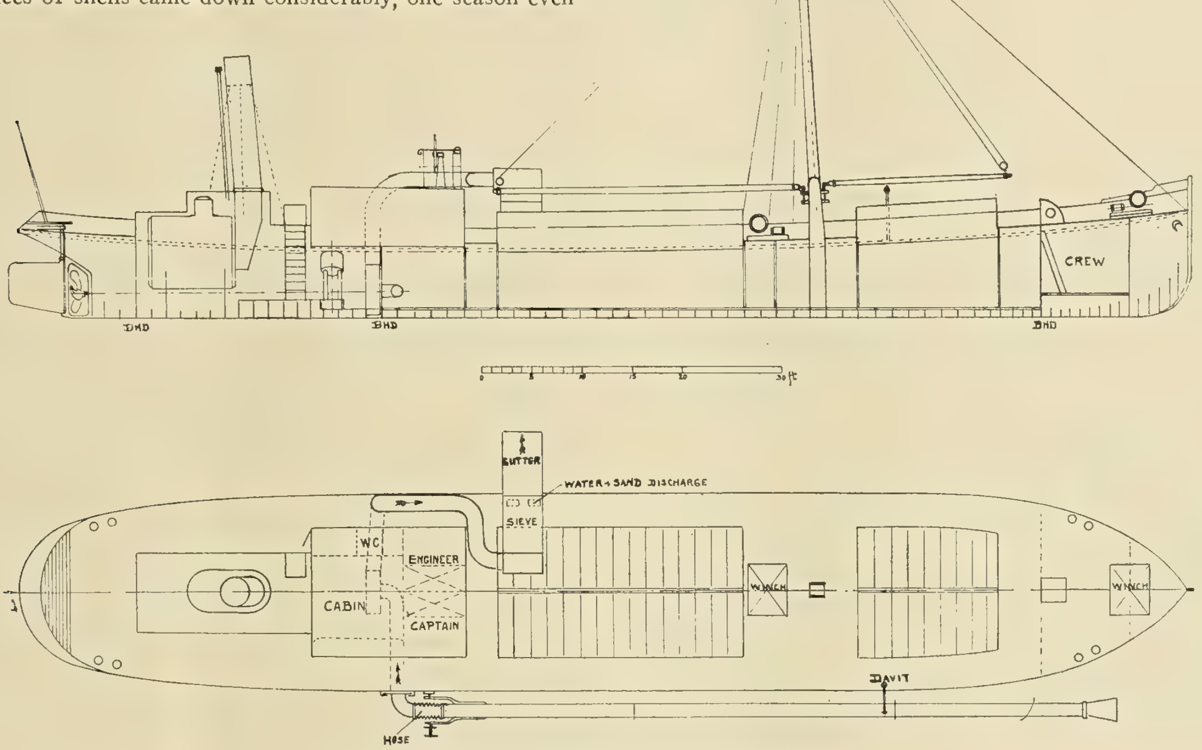
BY F. MULLER VAN BRAKEL

Much of the lime used in Holland is shell lime, produced from the shells that are dug up at the sea coasts. Some twenty years ago this was done exclusively by hand, by means of iron-hooped bags attached to long poles, handled by a man standing on a barge. The total weekly output was necessarily very small; it was well paid, however, the price being about $4 (16s. 8d.) per 100 cubic feet, as the supply did not in any measure answer the demand. It will be understood that, if the hand work was paid well, the man who first introduced a barge with a steam engine driving a centrifugal sand pump was paid better still, as the demand remained the same and the prices did not come down much. It is said that two seasons made this inventor a rich man. Of course, many wanted to follow this example, and several shell suction dredgers were built, some driven by steam engines and some by oil motors. The prices of shells came down considerably, one season even to 70 cents (2s. 11d.) per 100 cubic feet. Since then, however, the market recovered somewhat.

One of the latest of these shell dredgers was built in 1908 by Messrs. E. J. Smit & Son, of Hoogezand, Holland, to the order of Messrs. G. Doeksen & Sons, of Terschelling. The ship is named *Willem Barendsz,* after the famous Dutch Arctic explorer, who in 1696 tried to force the Northeast Passage, but, after losing his ship, was forced to pass the winter on Nova Zembla, and died in an open rowboat during the return voyage. The principal dimensions of the *Willem Barendsz* are:

Length between perpendiculars......	108 feet.
Beam	20 feet.
Depth	7 feet 3 inches.

The hull is built entirely of steel to the rules of the German Lloyd's under special survey. The engine room is aft; the propeller shaft passing under the boiler as the engine and pump are placed close together towards the center of the ship. The accommodation of the staff is in a roomy deck house on the deck near the engine room; the crew's quarters are forward under the deck. Between the engine room and crew's quarters all space is taken up by the hold, which may be filled with shells should no lighters be obtainable, and which gives opportunity to use the ship as a freight steamer during winter time. Usually, however, the shell is delivered into lighters and the hold is used as a coal bunker and workshop. The steering wheel and compasses are on top of the deckhouse, giving a free outlook over sea, which is necessary when navigating on the shoals near the Dutch coast and between the many islands.



ELEVATION AND PLAN OF DUTCH SHELL SUCTION DREDGER

A strong pole mast, 46 feet from the deck, with two derricks, is fitted between the two hatches, with a strong steam winch for handling the shell sieve, suction tube or cargo, or for coaling the ship. A heavy steam anchor winch is fitted forward, with a special head for hoisting the suction tube.

Propelling Machinery

The engine and boiler are built to the requirements of the German Lloyds. The 7-foot boiler has a heating surface of 430 square feet and produces steam at a pressure of 160 pounds. The engine is a diagonal one-crank compound engine; cylinders, 9 inches and 16 inches by a 12-inch stroke, which at 200 revolutions develops 110 indicated horsepower.

Air, circulating, feed and bilge pumps are driven from the low-pressure crossheads, and placed on the side where the condenser is attached to the ship's side. An independent steam pump is fitted for boiler feeding and auxiliary purposes. All sea valves are placed on the starboard side, as the water and sand delivery is on the port side. The crankshaft has a coupling flange at each end; the forward one connecting to the pump, the after one to the screw shaft, which bears a four-bladed propeller of 4 feet 3 inches diameter and 5 feet 9 inches pitch.

Dredging Apparatus

The general arrangement of the pumping installation is rather like that of an ordinary suction dredger.* In determining the principal dimensions of pump and suction tube, however, and when fixing the usual number of revolutions, the difference between sand or mud and shells should be taken in account. Experience is here, as in all other cases of engineering, of the first importance.

Pump

The pump is of the ordinary sand-pump type as generally constructed in Holland and Germany. The inner circumference of the casing follows closely the circle described by the impeller blade tips, and only about one-third the circumference deviates from that circle to give access into the delivery tube. There is thus a marked difference between this pump and the ordinary water pump, whose inner form follows a spiral line all around the circumference. It may be mentioned here that the Polson Iron Works, Toronto, and the Nagel & Kaemp Company, Hamburg, Germany, have recently constructed successful sand pumps of the spiral form.

The three Bessemer steel blades of the impeller are slightly curved backwards and attached to the heavy wrought steel impeller arm by screw bolts. As the wear and tear caused by the continual rapid passage of water, sand and shells is tremendous, the pump should be easy to overhaul and fitted out with wearing plates inside, which may be readily renewed. A water chamber is cast onto the stuffing-box, into which water is forced by an independent steam pump or by a branch from the circulating pump delivery. This causes a slow, continual flow of water from the outside, along the shaft, into the inside of the pump, thus preventing any sand getting in between stuffing-box and shaft.

Tubes

The suction tube is attached by a short leather hose, strengthened by a steel mail to a cast iron bend which communicates with the pump tube inside the ship. This bend, as well as the end of the suction tube, can be lowered and raised by appropriate hoisting tackle, and the whole tube with bend and all can be hoisted and stowed on deck when the ship is to sail into harbor.

The delivery tube passes from the pump through the deck-stringer, and leads by way of a sectioned tube to the shell sieve.

Sieve

This sieve rests on rollers which are fitted underneath on the bulwark and on the hatch coaming, and thus may be rolled all along the hatch when the dredger is filling its own hold. The sieve consists of an open rectangular box, in which the sieve plate (5/16-inch steel plate with holes punched close together) is fitted in a horizontal position on three steel bars. The water and sand pass through the sieve plate to a square tube which discharges overboard near or at the waterline. The shells are waterborne while on the sieve, and thus easily shoveled off by one or two men to the inside when loading the ship's hold, or to the outside through a gutter leading to the hold of the other vessel.

Some shell dredgers have a rotating shell sieve of cylindrical form, which is driven by a small steam engine. Though using a great quantity of steam these sieves are capable of dealing with huge quantities of shells and even of assorting them in two sizes and charging two vessels at the same time with different sizes of shells. This, however, is only possible when the suction tube is fitted in the middle line of the ship.

Management

Proper design and reliable construction are the first steps necessary to get a successful shell dredger, but an experienced skipper, who knows where to find shells and how to regulate the number of revolutions of the pump that it may be most efficient, is no less important. It is a common observation on shell dredgers that for a long time only sand and water are brought up, till all at once at a certain number of revolutions the shells appear. The skipper therefore has his place near the sieve, and observing the delivery of the pump, regulates the number of revolutions accordingly by means of a hand-wheel which is connected to the steam throttle valve.

The *Willem Barendsz* has proved to be a very successful dredger, and has many times beaten other dredgers of greater power. As pointed out above the efficient design and construction are not the only causes of this. A great part of the success is due to the skillful and tenacious handling by the crew, who every year keep up dredging till the December storms prevent other vessels coming alongside to take in shells.

The biggest delivery for one day of fifteen hours has been 4,300 cubic feet; a mean delivery of 1,500 to 2,000 cubic feet in fourteen hours is more usual, working from 175 revolutions, when the impeller blades are new, to about 210 revolutions when they are worn away. The steam pressure when dredging is usually 125 to 135 pounds. The crew consists of a skipper, engineer, mate, fireman, two deck hands and cook.

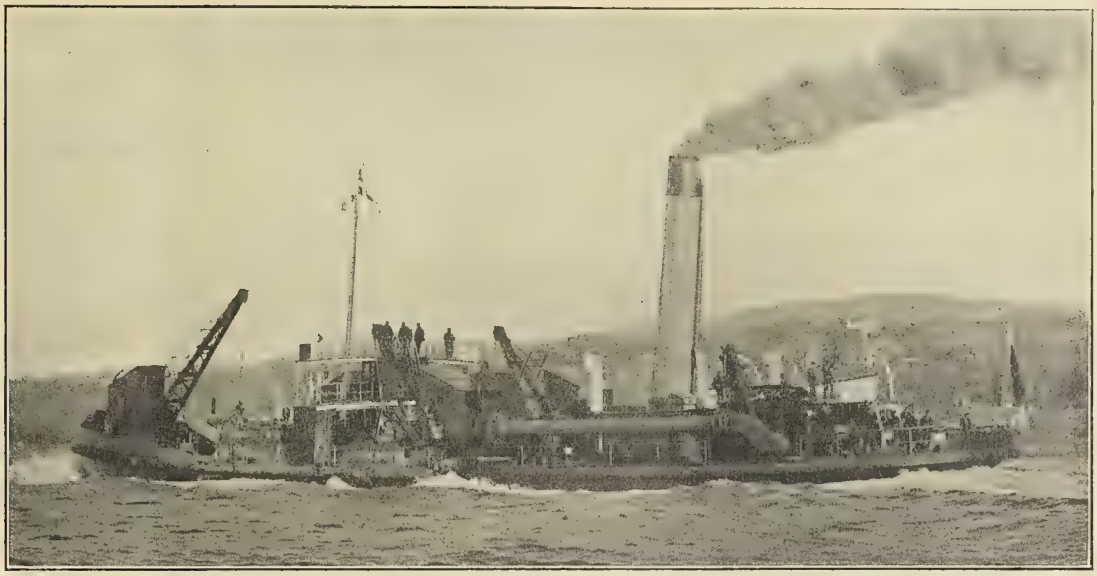
* For a very complete and fully illustrated article on sand pumps and gear, see *Zeitschrift des Vereines Deutscher Ingenieure*, 1909, page 969, and 1910, page 657.

Dredger Rhyl for the London and North Western Railway Company

Messrs. Ferguson Bros., of Port Glasgow, have built a powerful twin-screw combined suction and grab dredger named the *Rhyl* for the London & North Western Railway Company's service at Garston, on the Mersey. The vessel is classed 100 A 1 at Lloyd's, and has been constructed to the specification and under the direction of Commander G. E. Holland, C. I. E., D. S. O., marine and dock superintendent for the company. The four powerful grab cranes are arranged at each corner of the hopper, one of the forward cranes having an extended jib to reach over the bow for dredging in confined spaces.

The machinery consists of twin-screw, triple-expansion propelling engines with a full set of modern auxiliary machinery, comprising one set of Weir's pumps, a feed heater filter, duplex, ballast and separate air and centrifugal circulating pumps. Electric light is fitted throughout. The sand pump is arranged in a separate engine room, and is driven by a set of compound marine type engines, the suction is fitted under the waterline, and has a slide for raising and housing the pipe inboard. This arrangement has some special features which are free from the complications usually found in this type of fitting. Steam is supplied by two double-ended boilers, the working pressure being 160 pounds per square inch.

This is the fourth vessel built for the London & North Western Railway during the last four years by Messrs. Ferguson Bros.



SUCTION AND GRAB DREDGER RHYL

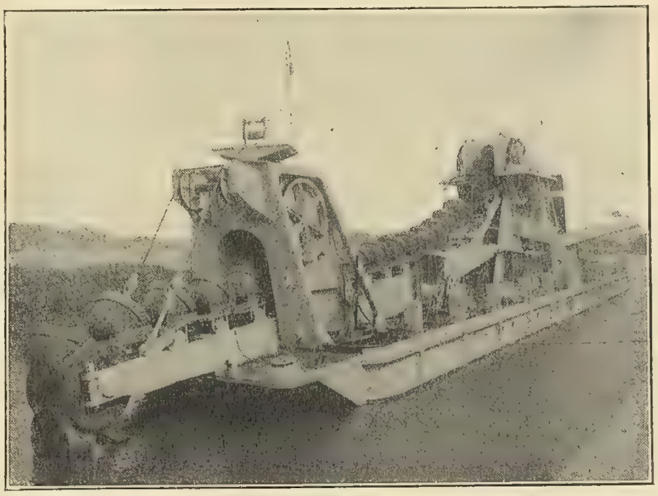
Rotterdam Dredges

Several interesting dredgers of both the bucket and the suction types have been built recently by the Establissement Fijenoord, Rotterdam, Netherlands. The latest of these are of the following dimensions:

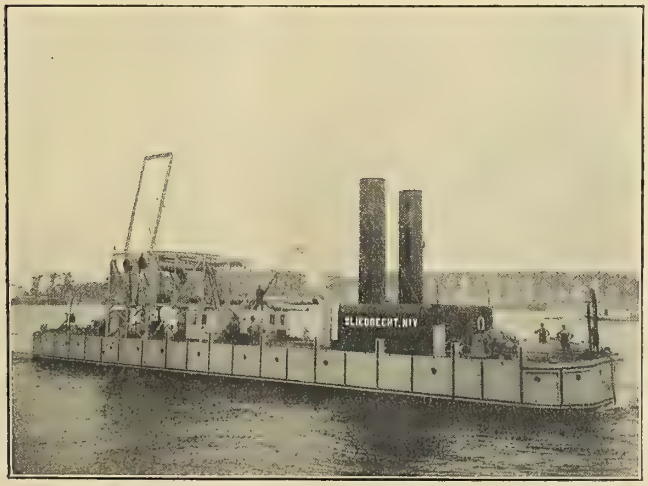
Name	Maashaven.	Sliedrecht V.	Europa and Amerika.
Type	Suction-dredger.	Suction-dredger.	Bucket-dredger.
Owners	G. A. van Hattem, Dordrecht.	L. Volker, Sliedrecht.	J. P. Heyblom, Rotterdam.
Length	124 feet	144 feet	148 feet
Breadth	22 feet	31 feet	25 feet
Beam	10 feet	13 feet	11 feet 4 inches
Draft	5 feet 9 inches	6 feet 5 inches	5 feet 7 inches
Engines	Sand pumps 300 indicated horse-power. Water pumps 150 indicated horse-power.	Sand pumps 700 indicated horse-power. Water pumps 200 indicated horse-power.	200 indicated horse-power.

The bucket dredgers deliver the spoil into hopper barges placed alongside. The shoots are movable for this purpose. The dredger can work to a depth of 40 feet with the ladder in its ordinary position, while by altering the upper bearing of this to a special support the depth reached can be extended to 60 feet. The bucket capacity is 21 cubic feet; speed, 12-18 buckets per minute.

The suction dredgers are designed for unloading barges alongside, and delivering the sand or heavy clay at a long distance through a piping arrangement (the *Sliedrecht V.* delivers up to a distance of 6,500 feet). The *Europa* and *Amerika* are constantly at work in the Suez Canal, the *Maashaven* at the harbor works in North Germany, and *Sliedrecht V.* mostly for the Municipal Works of Rotterdam.



EUROPA



SLIEDRECHT NO. V

The Bureau of Navigation reports 1,051 sailing, steam and unrigged vessels of 151,341 gross tons built in the United States and officially numbered during the nine months ended March 31. Of these, 21 aggregating 20,258 gross tons and 18 aggregating 52,895 gross tons were steel steamships built on the Atlantic and Gulf coasts and on the Great Lakes, respectively. During the corresponding nine months ended March 31, 1911, a total of 987 vessels of 228,677 gross tons were built in the United States. The total built during the month of March this year is 130 vessels of 18,829 gross tons.

Notes on Hydraulic Dredge Design

BY M. G. KINDLUND*

It is the intention of this article to discuss briefly a few of the problems that confront the engineer in the design of hydraulic dredging plants. Only those dredges discharging through long pipe lines will be considered at this time, as a greater diversity of experiences and of opinions seems to exist in regard to this type of machine than to those discharging directly into hoppers or barges.

Theoretical considerations are usually not given much thought in ordinary dredging operations, and unless the contract in hand involves a large amount of money and extends over a considerable length of time, it is of perhaps small consequence whether the conditions are met by a suitable design or not. It is usual to employ the same plant on many contracts, and it is obviously an advantage to suit average conditions that experience teaches us are most liable to be encountered. However, there are many times when a careful study might profitably be made of special conditions that can only be successfully met by alterations in existing designs or by building an entirely new plant. The preliminary expense and delay will be amply justified by results, as has been demonstrated many times. The greatest efficiency is desirable in a plant working so continuously as does a dredge, and the utmost care exercised to guard against breakdowns that involve loss of time. To every dredging contractor the pertinence of the ancient proverb, "Time is money," has been brought home more than once.

Five considerations have been selected from among a number, which will be taken up in the succeeding paragraphs:

1. The selection of the proper size of pipe.
2. Determining the power required.
3. Design of the pump.
4. Auxiliary deck machinery.
5. Hull.

Proper Size of Pipe

Hydraulic dredging is a process whereby solid material, heavier than water, is transported through pipes by virtue of the velocity of a current of water. The prime requisite, then, is velocity. By reference to the following table the effect of increasing the size of pipe on the quantity of water pumped with the same expenditure of power is shown:

Diameter of Pipe in Inches	Quantity of Water	Percent Increase
16	100	..
18	122	22
20	145	19
22	170	17
24	195	15
27	238	22
30	283	19

It is seen that, theoretically, by increasing the diameter of pipe a single size the efficiency of the operation may be increased from 15 to 22 percent. Here are two conditions that the designer has before him: First, the smaller the diameter of pipe he uses the higher the velocity and the greater the percentage of solids in the mixture transported. Secondly, the larger the diameter the greater the volume of mixture that will be carried for a given expenditure of power. He must find the proper size of pipe that will ensure a sufficient velocity to carry the material in suspension and at the same time give the maximum discharge obtainable.

Light material, silt and fine sand, are easily carried in suspension by the water. For these a greater diameter with lower velocity may be employed than for coarse sands and gravel. A limit to the velocity of discharge is reached when the friction head begins to increase at too rapid a rate. This critical velocity, as it may be termed, for sizes in the neighborhood of 20 inches occurs at about 12 feet per second. Not only does the friction become excessive beyond this point, but if sand is being pumped the abrasive action on the internal surface of the pipe becomes too severe. Thus a practical limit is set for sand dredging, which it is not wise to exceed. A gain in proportion of solids transported may be offset by the necessity of more frequent renewals of discharge pipe. The accompanying set of curves demonstrates quite clearly the rapidity with which the power increases with small increases of velocity. These curves were prepared from data obtained during a series of tests of a 24-inch dredging plant pumping water through varying lengths of pontoon and land pipes. The friction factors are much in excess of those commonly used for cast iron pipe, as might be expected, and are higher for pontoon pipes connected by rubber sleeves than for land pipe, the ends of which are telescoped one into the other.

For those dredging contracts where the greater part of the pipe rests on the fill, or is carried across intervening ground, instead of being supported by floating pontoon pipes, the labor involved in handling the large sizes, *i. e.*, changing from one position to another, turning the pipe around, telescoping and packing the ends, etc., sometimes prohibits the use of the most economical size. Under certain conditions the consequent loss of time and extra labor may counteract the increased efficiency.

Thus practical as well as theoretical limits are set for both minimum and maximum sizes of discharges, but it is manifest that the selection of the proper intermediate diameter is a matter of serious consequence. On an extensive piece of work it may mean either success or failure.

The results of dredging contracts with which the writer is familiar, extending over long periods of time, show it to be true that the effect of using too small a pipe is to diminish the output in cubic yards in a degree commensurate with that obtaining for water. As noted above this may vary between 15 and 22 percent. It has been demonstrated, for instance, that for the same expenditure of power 20 percent more material can be transported through 27-inch pipe than through 24-inch pipe. Practice and theory agree, then, that the most efficient size pipe to use for any given power is the largest size in which a velocity can be maintained sufficient to carry in suspension the material encountered.

Power Required

Now, turning to the determination of the required power to meet conditions we find the following factors entering in:

(*a*) Diameter of suction and discharge pipe.

(*b*) Kind of pipe, length of each kind and character of end connections.

(*c*) Static head.

(*d*) Design of such details as suction head, stone box, ball joints, non-return valve and bends in hull pipe.

(*e*) Efficiency of pump and of engine, which may vary from 35 to 70 percent.

(*f*) Nature of the material and the proportion of solids to total mixture transported.

The effect of diameter of pipe on the necessary power was taken up in the preceding paragraphs. As regards the kind of pipe used and end connections of same, the friction coefficients for floating pontoon pipe are in excess of those for land pipe by amounts varying from 35 to 45 percent, depending on the

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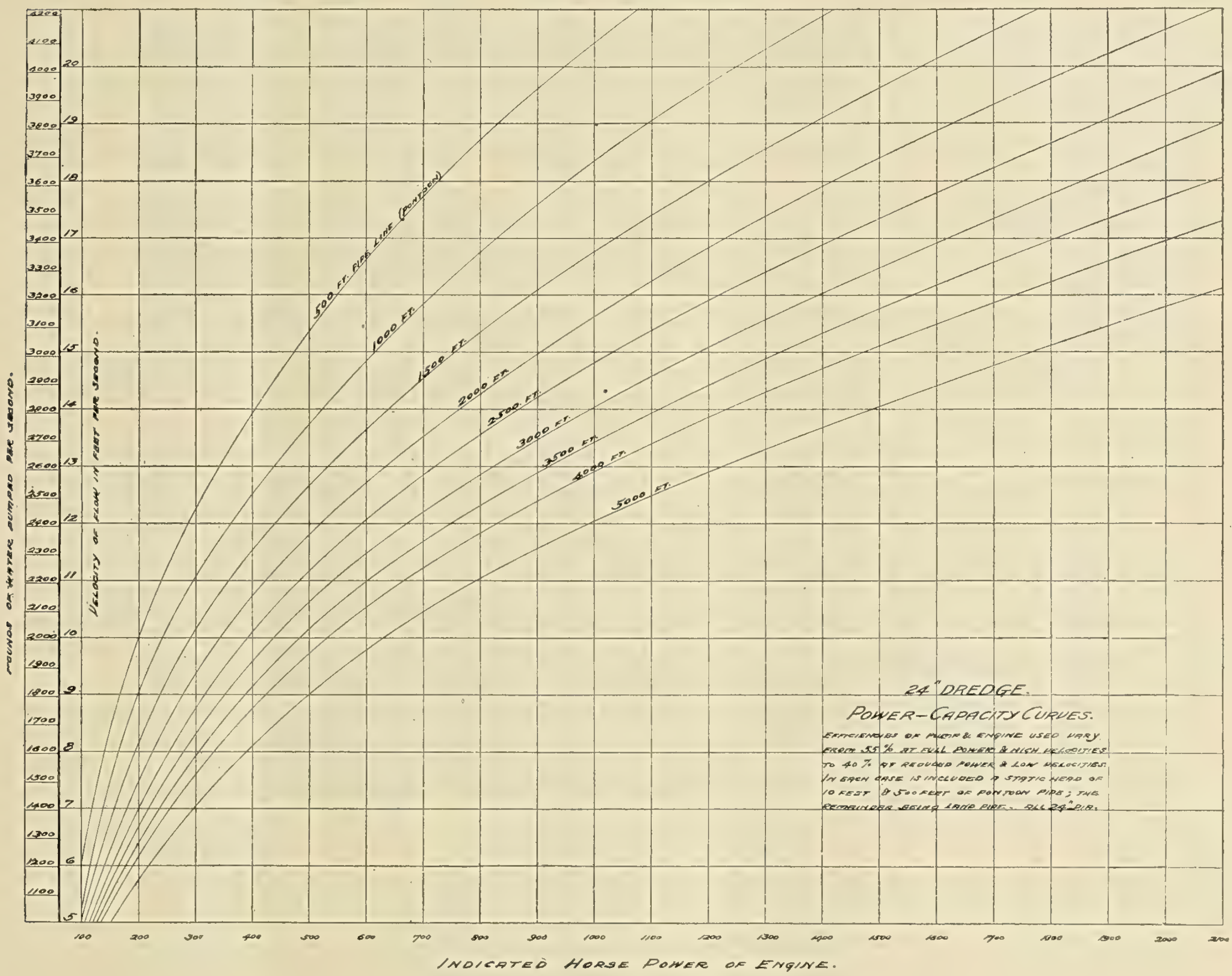
velocity of current. For instance, at a velocity of 10 feet per second the friction head per thousand feet of pontoon pipe is 17 feet, while for land pipe it is 12.5 feet. Similarly, the values at 15 feet velocity are, respectively, 38 feet and 26.7 feet. These figures include suction, discharge and velocity heads; but, of course, no lift, and were determined for 24-inch pipe pumping water only. They are well above the friction heads for cast iron pipe, and show the effects of sudden expansion at the rubber connections, of an occasional short bend common in dredging, of the irregularity of flow through pipe lying on uneven ground, and of a few small leaks that it is almost impossible to prevent. Were dredging mixtures carried through pipe of uniform diameter, with long radius bends, smooth joints and no leaks, the price per yard charged by contractors would be considerably lower than obtains at present.

The indicated horsepower of the engine is given by *I. H. P.* $= W \times H \times k$, where W is weight of mixture transported per minute, H is total head in feet, k is a coefficient representing combined efficiencies of pump and engine.

The total energy imparted to the fluid, whether it be water or a mixture of sand and water, is expended outside the pump itself, in overcoming entrance head, friction in pipes, actual lift and in creating velocity. All this is included in the term "head."

The most obscure portion of the calculation for horsepower is the determination of velocity of flow necessary to transport a given percentage of solid matter, and also the increased friction head due to this mixture. We know from experiments the power required to pump water through dredging pipe per thousand feet. We know from the results of dredging operations the approximate proportion of solids transported for a given power with varying lengths of pipe line. On long lines the solid material is sometimes not more than 5 percent of the total, even though the mixture has been "saturated" most of the time, as it is, of course, the endeavor of the dredge operators to carry the maximum quantity without clogging.



POWER-CAPACITY CURVES FOR A 24-INCH DREDGE

We find that up to lengths of 1,500 or 2,000 feet the current is not usually saturated; that is, the yardage is not proportional to the length of pipe line, as is the case beyond these lengths. This is due, of course, to the failure of the suction to gather in sufficient material. Either the apparatus designed for loosening the earth and sand or cutting the clay is not effective, or else the suction head is not properly shaped to introduce the material into the pipe. Then, too, there is a limit to the power of the suction, no matter how great the velocity of flow may be, and material outside of its influence cannot be dislodged. A form of scraper head, such as is used quite generally on Government dredges, is well adapted to handle silt and fine sand, and the Frühling type of suction head, with provision for diluting the mixture at will to the proper

consistency for pumping, is admirably suited for light material, particularly in the case of a hopper dredge, where the discharge line is very short.

In the absence of reliable data, derived either from practice or experiment, on the increased friction head resulting from carrying varying proportions of sand, it seems fair to the writer to assume that the head will vary directly as the density of the fluid as long as the velocity is sufficient to carry the solids in suspension. If any readers of this article know this to be an unjust assumption for the sand percentages ordinarily found in practice, say up to 25 percent, the writer would consider it a favor if he were corrected. This assumption does not hold in the case of argillaceous earths, which exert far less frictional resistance to hydraulic transportation, and there are certain unctuous clays which even seem to contribute to the facility of their own removal. Of course, the weight of fluid transported may be easily computed for a given proportion of solids, and so the first two factors in the estimation of horsepower may be obtained. The third factor—efficiency of pump and engine—will be taken up in the following paragraphs:

Design of the Pump

The pump, the so-called "heart" of a suction dredge, is perhaps the most important feature of the plant, for on it depends, in large measure, the efficiency and capacity of the outfit. When sharp sand is encountered the wear on the internal surfaces is so great that the time and labor necessary to renew the worn parts becomes a serious consideration. If liners are used they may be arranged to facilitate renewals, as the maximum wear occurs always in the same parts. High-carbon steel plate liners give perhaps the best service, neglecting manganese steel, but even these will be cut through surprisingly fast. With unlined pumps there have been times when 1,000 hours of dredging have worn a 2½-inch cast iron case entirely through. Manganese steel liners are sometimes used, which, of course, have a much longer life. Recently manganese steel castings have been employed for the entire pump case, the drilling and tapping being accomplished by providing cast iron inserts in the flanges and elsewhere where necessary. The faced portions are ground, and so a practicable pump case is constructed from a steel that resists machining, but resists likewise the abrasion caused by sand and the blows of solid objects.

The writer has seen a plate liner cut through at the line of maximum wear, *i. e.*, at the tip of the runner blades, causing a point of the plate to bend out far enough for the runner to strike it. The plate was torn and curled up like a shaving of wood through an arc of about 90 degrees until the resistance stopped the engine. Is it any wonder that pumping engines on a dredge have to be strongly built, when they may be thus brought to a dead-stop from 200 revolutions per minute through a quarter turn?

High efficiency is something striven for but rarely attained in a dredge pump. Certain fundamental requirements for efficiency are impossible where large, hard objects have to be handled. It is surprising, by the way, to one unfamiliar with hydraulic dredges to learn of the strange and apparently unmanageable objects that pass into the suction and out of the discharge, perhaps half a mile away. Stones about 18 inches square and 24 inches long have made the trip through a 20-inch diameter pipe; likewise pieces of 3-inch pipe, 36 inches long, with fittings at the ends, lengths of chain, big chunks of concrete, pieces of wooden piles, etc., have been picked up on the fill or removed from the pump casing. This indicates the eminent desirability of spaciousness in the pump passages, and this very requirement precludes anything more than a fair efficiency, say 50 percent. The following brief explanation will outline the reasons for this:

The energy imparted to the mixture of water and solids in its passage through the runner or disk is in two forms, potential and kinetic, *i. e.*, pressure and velocity. The pressure is due to the action of the centrifugal force of the rotating mass contained between the vanes, and the velocity approximates to the peripheral speed of the runner. The radial component of this velocity should be as great as possible, and this may be accomplished by tapering the sides of the runner to gain a gradually decreasing section as the distance from the center increases. The object sought is a more nearly uniform radial advance of the column of water. This, of course, is out of the question for a pump whose minimum clear passage should be at or near the center, where any obstruction may be easy of access from the suction manhole. Thus the velocity is almost entirely a "whirling" velocity, and as the water is discharged directly from the runner into a large chamber the kinetic energy is practically all lost. The converting of this energy into pressure, by a throat or expanding passageway leading into a volute, accounts for the relative high efficiencies of centrifugal pumps handling water only.

The only theoretical advantage possible for a dredge pump is the provision of a volute case, where increasing quantities of water issuing from the runner at increasing distances from the point of discharge, in the direction of rotation, may meet water flowing around the casing at nearly uniform speeds. A volute, or modified volute, case is desirable for sand pumps, but the extra efficiency gained is hardly appreciable when the other theoretical advantages are not at our disposal. Extensive tests with dredging pumps participated in by the writer, and the results of which he is familiar with, have demonstrated that there is very little or no gain in efficiency due to the volute form of casing. The same pump was used under identical conditions, pumping water first with a circular case and then a volute, and practically the same efficiency resulted.

The type of runner, likewise, does not very materially affect the efficiency. Either open or closed runners may be designed to give equally good results. The capacity, however, is usually greater with a closed or shrouded runner. The tests above mentioned show this to be true, and those conducted by the Government engineers on the Mississippi River dredges prove it conclusively. A closed runner on the dredge *Epsilon* showed 12 percent more capacity than an open runner on dredge *Zeta*, the pumps in other respects being identical. On the *Zeta*, furthermore, three runners, with 3, 5 and 7 blades, were tested, the efficiency varying but slightly, but the capacities of the 5 and 7-bladed runners were, respectively, 25 percent and 27 percent greater than the one with the three blades.

The outstanding advantage of the closed runner, however, lies in the greatly reduced wear on the internal surfaces of the pump. There is not the continual grinding action of the sand between runner blades and casing, with the necessity of renewals and loss of efficiency due to enlarged clearances; there is no "spilling" over the edges, so to speak, but the mass of water and solids is confined between the faces of the runner. Of course, the disk of the latter is subject to wear, but this is comparatively unimportant. A closed runner, furthermore, may be more easily balanced. In the writer's opinion this type is much to be preferred.

Auxiliary Machinery

The auxiliary machinery required to move a dredge not self-propelled, to raise and lower the ladder supporting suction pipe and cutter, to raise and lower the spuds and to perform other deck operations, is capable of decided improvement on the majority of dredges built in this country. First cost has much to do with the rather crude apparatus often employed, but many times it is due to lack of attention to details. It is left to the last, has to be hastily erected, and made to suit the construction of hull and upper works. Fortunately, greater

care is now being given to this feature of dredge operation than formerly. This is apparent in the more compact arrangement of drums, frictions, etc., and a more rigid connection to a bedplate extending under all bearings; cut steel gears have replaced rough cast iron, clutches and brakes are operated by steam rather than by hand. The results have been manifold; gears are less easily broken, the life of bearings is lengthened, vibration and noise are reduced, less power is required, and a reign of intelligence rather than brute strength on the part of the operator has been inaugurated. There is still room for improvements, and these will come as machines are built to last instead of being put together for specific contracts.

HULL DESIGN

In conclusion, a word may be said about the hull proper. It should be laid out last and designed to suit the machinery, which, it is needless to say, is arranged as compactly as possible. Too often hull construction comes first, and features are introduced that preclude the most desirable placing of machinery. It is, of course, very important to have rigid foundations for the engine, pump and auxiliary machinery, and that the hull generally be strong enough to resist hogging and sagging strains. But this result may be obtained by suitable construction, especially when steel is employed for hull material.

The writer has proposed a composite construction combining some of the advantages of both wood and steel, giving a very rigid structure in a fore-and-aft direction and a space below deck free from massive wood trusses and bulkheads, while preserving the unquestioned advantages of wood planking and decks. A complete steel hull is considerably more expensive than wood, but when kept properly cleaned and painted will outlast two wood hulls, and when its advantages as regards strength, convenience of arrangement, ease of providing rigid foundations for machinery, etc., are considered, it seems to be the better investment.

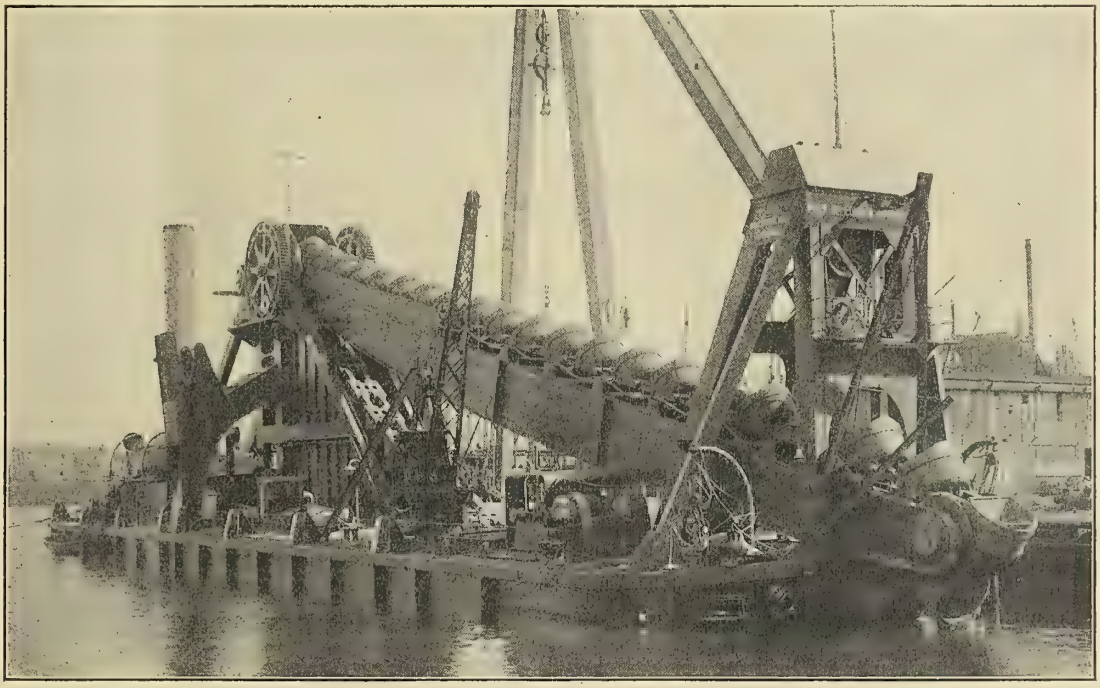
It has been impossible to touch upon a number of points in connection with dredge design that would be of interest, among them being the cutting apparatus and the possibilities of types of pumping engines at present not generally used. Perhaps another opportunity will be offered in these columns for their consideration.

The Largest Bucket Dredger on the Thames

The largest bucket dredger on the Thames was built by Lobnitz & Company, Ltd., of Renfrew, to the designs of the Port of London Authority Engineers. It was named *P. L. A. No. 6*, and has been in operation on the Thames since October last. The dimensions are as follows:

Length	214 feet.
Breadth	40 feet.
Depth	12 feet 6 inches.
Dredging depth..............	55 feet below water level.
Capacity of buckets..........	27 cubic feet each.

The dredge is fitted with triple-expansion engines, two large return tubular marine boilers and very powerful mooring and ladder hoist winches.



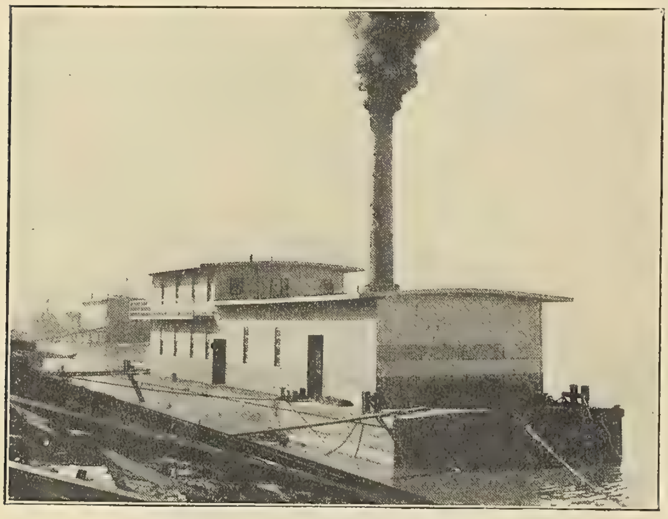
LOBNITZ DREDGER P. L. A. NO. 6

The Dublin Dockyard Company, North Wall, Dublin, are just completing a hopper grab dredger for the Limerick Harbor Commissioners, which has been specially designed by the builders for the owners' particular requirements. The dimensions of the vessel are as follows: Length between perpendiculars, 140 feet; width, 29 feet 6 inches; depth, 12 feet 6 inches, and she is capable of carrying 500 tons of spoil on a draft of 11 feet. She is built of steel to Lloyd's highest class and under their special survey, with additional strengthening for loading on ground. The propelling machinery is placed aft, and consists of a pair of compound condensing engines having cylinders 15 inches and 32 inches diameter by 24 inches stroke. Steam is supplied from a cylindrical return tube boiler 12 feet diameter by 10 feet long, working at 120 pounds pressure. The dredging machinery, consisting of two of Messrs. Priestman's powerful grab dredgers capable of lifting 80 cwts. each from a depth of 45 feet from the vessel's deck, and the forward dredger is designed to work all round so that vessel may cut her own flotation. The specifications for the vessel are very full and call for the most complete equipment.

Test of a Mississippi River Suction Grader

BY THOMAS C. ALLEN

For the purpose of grading the banks of the Mississippi River at certain places the engineers of the Mississippi River Commission make use of a jet of water projected into the bank at high velocity. The operation is similar to the hydraulic mining once so common in some of the gold districts of California. Heavy brass nozzles on the end of very high-pressure hose are used, and the process consists essentially in washing the earth from the banks into the river. The pumping equipment is installed in a houseboat, which is not provided with motive power of its own. This boat is towed along the river as close to the bank as the depth of water will permit. Originally heavy direct-acting pumps were in use for this work, but in grader *No. 1022*, recently built in the Government yards at Memphis under the direction of Capt. Clark S. Smith, Corps of Engineers, U. S. A., an equipment



MISSISSIPPI RIVER COMMISSION GRADER NO. 1022

has been installed by the Allen Engineering Company, Memphis, in which a unit driven by a steam turbine has been employed. This being somewhat of an innovation for this character of work, a brief description will prove of interest.

The hull consists of a barge 110 feet long, 30 feet wide and 6 feet in depth of side. The deck plan is a rectangle. In fact, except for a little sweep upwards at the bow and considerably less at the stern the entire hull has the form of a parallelopipedon. A deckhouse, set back 14 feet from the bow, measures 86 feet in length and 23 feet in width. A second-story at the forward end furnishes living quarters for the crew, and is provided with a balcony on three sides.

The machinery equipment consists in the main of a battery of three boilers, 40 inches in diameter and 26 feet long; one 210-horsepower, two-stage Terry steam turbine, and a four-stage, 8-inch Alberger turbine pump. The steam turbine, with 180 pounds working pressure and 26 inches vacuum, operates at 1,800 revolutions per minute, and is direct connected to the pump, which is mounted on the same base. The pump has a rated capacity of 1,200 gallons per minute against a total head of 480 feet, this including both suction and friction.

The auxiliary machinery includes one surface condenser of the water-works type, containing 470 square feet of cooling surface, supplied by the Wheeler Condenser & Engineering Company, a direct-connected horizontal wet vacuum pump, 6 by 8 by 10 inches; a Cameron feed pump, and a Sims closed type feed-water heater. The latter utilizes the exhaust from the two auxiliaries in heating feed-water for the boiler. The suction water from the river to the pump is the cooling water for the condenser.

This steam turbine is of the multiple-pressure stage type. In the high-pressure stage the steam is expanded from the live pressure down to approximately atmospheric pressure, and the energy is absorbed by a single wheel. In the second or low pressure stage the steam is expanded from the exhaust pressure of the first stage down to the vacuum as carried in the condenser, the energy being absorbed by two wheels in this stage. Each of these low-pressure wheels has its own system of jets and reversing chambers of the well-known Terry type.

The glands or stuffing-boxes are of the labyrinth type. Composition strips are set in a sleeve on the turbine shaft; these strips project above the surface of the sleeve, and are so placed that they are in approximate contact in an endwise direction with portions of the gland pot or body, which is fastened to the turbine case. In addition to the rings mentioned above each sleeve is equipped with split piston rings, which bear on their peripheral surface against a portion of the gland body. The portion of the gland between these two sets of rings is cored, and a connection is made between the high and low-pressure gland so that any steam which might get by the first set of rings on the high-pressure gland is collected in this cored space and led to the low-pressure gland; in this way absolutely sealing the low-pressure stage. The bearings of the machine are supported from the turbine case, so that any change of temperature, due to load, etc., in no way affects the alinement of the set. The pump and turbine are directly connected through a rubber bushed flexible coupling.

The contract with the Government called for a steam consumption test of the unit six hours in duration. The guarantee included 31.9 pounds of dry steam at 180 pounds pressure and 26 inches vacuum per water-horsepower delivered. Assuming a pump efficiency of 70 percent, which is guaranteed, this would mean a guarantee of 22.25 pounds of dry steam per brake-horsepower per hour at the pressure and vacuum above mentioned. The test was made by United States engineers, assisted by engineers from the Allen Engineering Company.

The speed of the turbine was taken by means of an indicator on the end of the pump shaft. The steam pressure was measured by a gage in the steam line close to the throttle, and its quality by means of a throttling calorimeter. The steam consumption was measured in the usual manner by means of two tanks carried on standard scales and used alternately for weighing the discharge from the air pump. The vacuum was measured by means of a mercury column; all temperatures were taken in mercury wells. The discharge water from the turbine pump was measured by means of a weir located on the bank, the water being carried to the weir by means of one of the high-pressure hoses. The total pumping head was measured by means of gages placed at the pump in both suction and discharge lines. All gages, scales and other measuring instruments were carefully calibrated and tested.

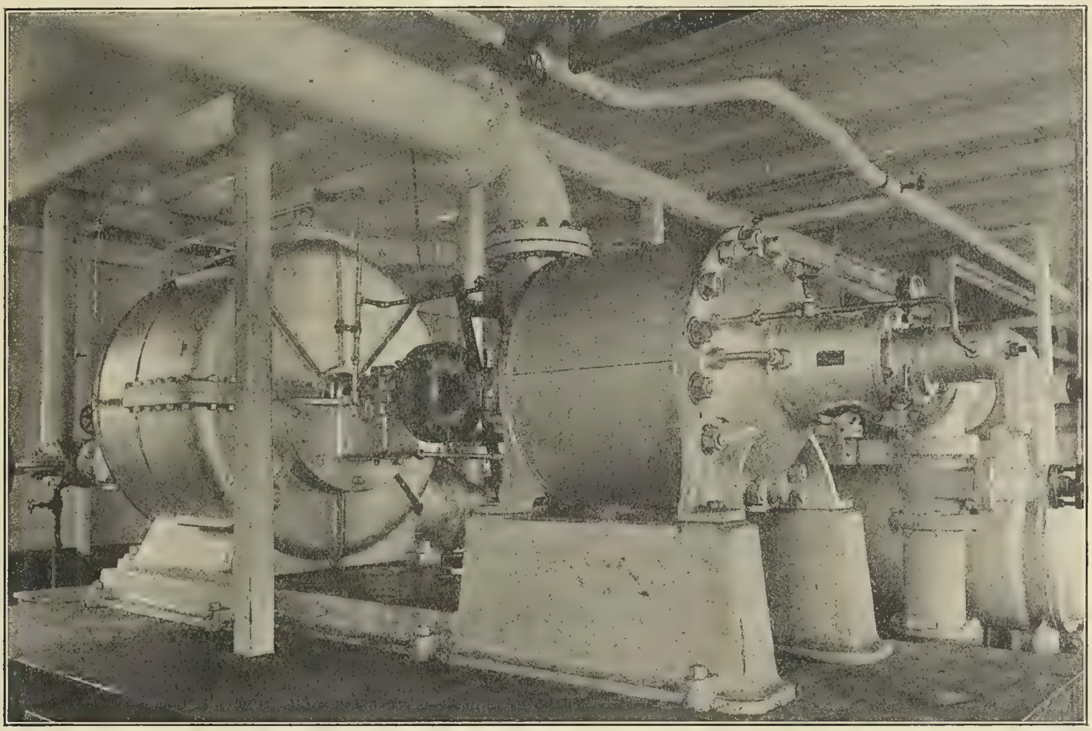
The steam consumption guaranteed covered the total consumption of the turbine and the wet vacuum pump. The exhaust line from the latter was therefore temporarily diverted from the feed heater into the condenser, in order that its exhaust might be included in the total. The conditions prevailing during the test were not exactly in accordance with those on which the guarantee was based. The corrections,

however, covering differences in steam pressure, vacuum and water-horsepower, were agreed upon beforehand. The results of the test, which proved very gratifying, showed an actual steam consumption of only 28.4 pounds per water-horsepower, against 31.9 pounds guaranteed, this being equivalent to 19.85 pounds actual for brake-horsepower against 22.25 pounds guaranteed. This shows an economy 11 percent better than was stipulated. At the same time the capacity of the unit in gallons per minute against the total head showed 11.5 percent greater than had been guaranteed.

The general summary of the test follows, the figures being averages of twenty-five readings taken 15 minutes apart. The date of test was Dec. 20, 1911:

Average steam pressure	180.9 pounds.
Quality of steam	95.02 percent.
Barometer	29.49 inches.
Vacuum referred to 30 inches barometer.	25.05 inches.
Pump discharge in gallons per minute	1,348.9
Total head, including suction & friction.	487.4 feet.
Suction head	14.4 inches.
Discharge head	207.2 pounds.
Water-horsepower delivered	167.1
Revolutions per minute	1,786
Pounds standard dry steam per water-horsepower	28.4
Pounds standard dry steam per water-horsepower guaranteed	31.9
Pounds standard dry steam per brake-horsepower	19.85
Pounds standard dry steam per brake-horsepower guaranteed	22.25
Pounds standard dry steam, total	4,746
Duty in million foot pounds per 1,000 pounds dry steam	69.85

From the plans it will be noted that a capstan at each end has been placed for towing and mooring purposes. It will also be noted that the three boilers discharge their products of combustion into a single tall stack. The suction will be seen to come from two square wells running down through the center of the hull, each having a suction head. One of these heads passes its water through the condenser and then into the pump, while the other discharges directly into the pump. In order to withstand the very heavy pressures to which the ultimate 8-inch discharge line is subjected, the latter is made of extra heavy pipe.



TERRY STEAM TURBINE AND ALBERGER TURBINE PUMP ON THE MISSISSIPPI GRADER

Twenty-Inch Hydraulic Disposal Dredge

The New York State Barge Canal construction has brought out several novel designs of dredges to meet conditions and the prices obtainable for the excavation. Most of the contracts for excavation have been let during years when the railroads were not building new lines or improving old ones, and consequently were not giving work to the contractors. As a result there has been considerable competition in bidding for the barge canal contracts and the prices have generally been low. Under such circumstances it has been necessary for contractors to go on the work with a plant modern in every respect and especially adapted to do that particular piece of excavation in the cheapest possible manner. This necessitated high plant expense, but it meant that the contractor would have the salvage value of this plant when he completed the work, rather than to have nothing to show but receipted pay rolls for perhaps a like amount of money. In other words, first cost was increased to keep down operating costs—labor was reduced to the minimum by increasing the cost of equipment. Plant is always an asset—receipted pay rolls are not.

Contract 18-B covers a section of the canal 5 miles long, and reaching from Mindenville to Canajoharie. The work comprises the canalization of the Mohawk River and the provision of proper entrances for several streams which will empty into the canal. As the canal for the most part follows the largest channel in the river, at scarcely any point did the entire prism of the canal have to be excavated. For long stretches only a very small percentage would be required. This small percentage might be a thin layer all across the bottom or might be concentrated at the toe of one slope. In other stretches there would not be depth of water for floating

anything drawing over a foot of water. The river often had two channels with low lying islands. The spoil areas, in the main, consisted of the abandoned channels behind these islands. Clearly dumping scows could not be used, as they would be aground on the material they dumped. Flotation was not sufficient for tugs. Some of the spoil had to be deposited on the islands. Unloading of deck scows by derricks and skips and distributing by cars was impossible. A large percentage of the material spoiled had to be placed in dykes which would be fairly compact and impervious to water. The larger stones could be used for paving the slopes as called for by the contract. Test pits were dug at many points, and it was ascertained that most of the material consisted of gravel with quite a large percentage of sand and large stones, the latter being of such size and quantity as to be likely to interfere with the continuous and efficient running of a centrifugal pump. In a great many places the gravel and boulders were so compacted as to prevent the successful employment of a hydraulic dredge with a powerful cutter head.

geared to the hoisting drum shaft, which in turn is geared to the backing drum shaft, this shaft carrying also the stern spud drum. The hoisting is by three parts of wire rope, the backing being wire rope also, both drums being grooved. The boom swings through an arc of 180 degrees. The hulls are 100 feet by 34 feet.

The stone scows are 13 feet wide and 28 feet long, built of timber and arranged as center dump.

The hydraulic disposal dredge has a spud at the stern and one near the bow to keep it anchored. These spuds are hoisted each by an independent engine. A hopper is mounted on the bow on the center line of the dredge.

On each side of the hopper are shaking tables upon which the material is dumped by the dipper dredges. The shaking of these tables works the material into the hopper in a steady stream. The hopper slopes down into the interior of a revolving screen, with holes of such a size as to allow the hydraulic material to pass through while retaining the stones to use for paving.

DREDGING PLANT ON THE NEW YORK STATE BARGE CANAL, WORKING BETWEEN MINDENVILLE AND CANAJOHARIE

After the foregoing facts had been established, the Bucyrus Company, of South Milwaukee, Wis., designed and installed for the contractors, S. Pearson & Son, Inc., the following plant to handle the work: It was decided to do the actual digging with two dipper dredges digging side by side and capable of excavating the entire prism. Between them were located a stone scow and a hydraulic disposal plant. There were thus four hulls lying side by side across the prism. This was not objectionable, as there were no waves nor any traffic to be hindered. The force of the current during most of the year is slight.

Timber hulls were used throughout as being cheaper and affording sufficient length of life to outlast the work. Bituminous coal was used for generating the steam for the engines throughout.

The two dipper dredges are of the usual patterns except that thrusting engines are provided on the boom to make it possible to dump the dipper at varying distances away from the side of the dredge. They have 3-yard dippers, timber booms, timber handles and vertical forward spuds with an engine for each for raising them and pinning up the dredge. The swinging circle is of structural steel and mounted on top of the trusses. The swinging drum is compound geared to an independent double-cylinder engine.

The main engines are 14 by 16-inch double cylinder, single

The material which passes through the holes falls into a sump below the water level and flows into the suction pipe of the 20-inch centrifugal pump together with the proper quantity of water, which is admitted to the sump from the river through a hole below the waterline of the dredge. The suction pipe leads aft to the pump, which is located at the stern. From here the material is discharged through a floating pipe line, which may or may not terminate in a shore pipe line, depending upon whether there is flotation on the spoil area.

The large stones which were refused by the screen pass by gravity to the lower end of the screen and from there into a steel box or skip resting on the deck. This skip may be raised by wire ropes hung from a rolling carriage mounted on two horizontal rails which extend entirely across the dredge with extensions, which either reach out over the stone scows or can be raised to a vertical position to allow another dredge to come alongside. When the skip is loaded it is raised, moved out over the stone scow and dumped by power. Before removing the loaded skip the mouth of the screen is closed by a door to prevent the stones from being discharged until the skip is ready for a new load. The operation of the door and of the skip is controlled by one man.

The two dipper dredges move ahead in the ordinary way, by dropping the dipper on the bottom, raising the forward spuds, pulling the dredge toward the dipper by the backing rope,

dropping the forward spuds and straightening up the stern spud.

The hydraulic disposal dredge is moved ahead by raising the forward spud and pushing down the stern spud by means of its engine. This spud is kept from assuming a vertical position, so that by pushing down with the spud the dredge is moved ahead away from the spud point. The forward end of the hydraulic disposal dredge is kept from swinging by lines to one of the dipper dredges.

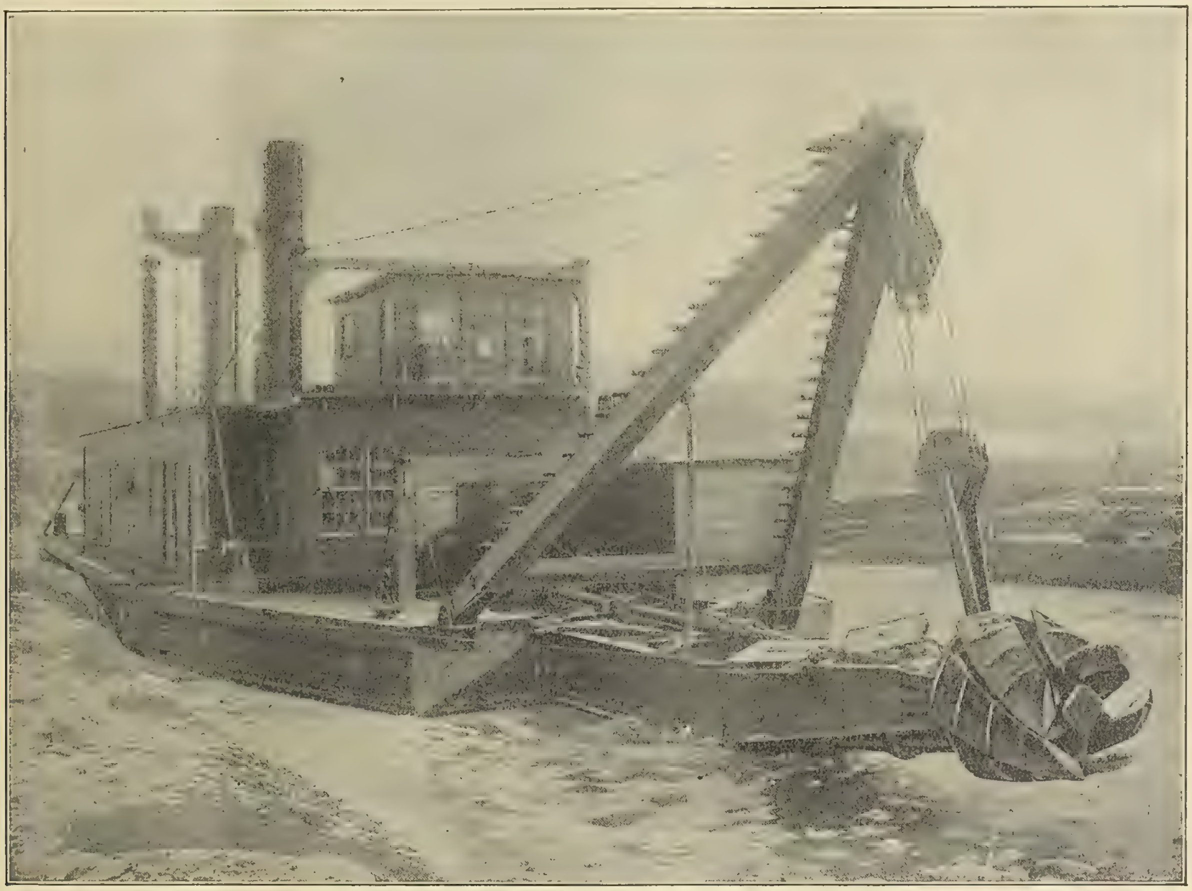
Of course, the size of the holes in the revolving screen may be varied if any decided change should occur in the nature of the material being handled.

A 20-Inch Morris Suction Dredge

The illustration on this page shows a 20-inch Morris suction dredge owned by the American Pipe & Construction Company, and used by them on their New York State Barge Canal contract at Canajoharie, N. Y. An exactly similar dredge has been used at Utica, N. Y., and the Morris Machine Works, Baldwinsville, N. Y., have in addition built five other 20-inch dredges that are in service on the New York State Barge Canal. The outfit has delivered through as much as 4,000 feet of pipe line with an elevation of 10 feet.

The boiler plant is arranged in two batteries, two 180-horsepower boilers to each battery. A surface condenser is used, having vertical air pumps and centrifugal circulating pumps; boiler feed pumps, service pumps, etc., are all of vertical Admiralty type.

The cutter ladder is of very heavy steel construction. The



MORRIS SUCTION DREDGE USED ON THE NEW YORK STATE BARGE CANAL

The hull of the dredge is of wood, with two heavy steel girders running fore and aft. Its length is 138 feet and its width 42 feet. The main dredging pump has a 20-inch suction and discharge, which is fully steel lined, and of steel construction throughout. It is directly connected to a vertical triple-expansion Morris engine that indicates 750 horsepower at 225 revolutions per minute. The cylinders are 15, 22½ and 36 inches in diameter, with a common stroke of 18 inches, and the engine operates with 200 pounds steam pressure. The pump shaft is 10 inches in diameter in the main bearing, and there is a five-collar steel horseshoe thrust to take the pump end thrust. The pump runner is 78 inches in diameter. This cutter shaft is 8½ inches in diameter, and the drive is through cast steel gears with cut teeth. The cutter-driving engine is a 12-inch by 12-inch double-cylinder horizontal engine placed on the deck. The winding engine is 8 inches by 12 inches, double cylinder, operating five drums. A 15-kilowatt electric lighting plant is installed, and the construction of everything throughout is of most substantial character. The dredge was designed with the object in view of eventually being used in salt-water service, as work on the New York State Barge Canal will not be of long duration. The canal is divided into three divisions—the eastern, middle and western. While in construction the canal is to be opened not earlier than May 15.

The Danish Suction Dredge Graadyb

BY AXEL HOLM

During the year 1909 the firm Copenhagen Floating Dock & Shipyard, Copenhagen, Denmark, built and delivered to the Danish Government's Water Construction Department the 900-ton suction hopper dredge described in the following:

In its working methods it comprises many radical departures from earlier-known dredges, and during last year's exhaustive trials these have proved to be very successful. The main idea was to get the discharge of the sand and water mixture from the suction pump into the hold to be a good deal below the overflow of the surplus water, thus giving the sand better conditions for settling down. With a total of 450 indicated horsepower working at the pump the sand room was filled in 36 minutes, and only very few traces of sand were found in the overflow, which must be called an exceedingly good result for a dredge of this size.

She is engaged on the rough western coast of Denmark in the North Sea, her main duty being to keep the channel clear to the harbor of Esbjerg, and these conditions also call for a good and steady sea ship.

She is built to the Bureau Veritas' class, I. Div., 3/3 R. I. I. P. R., Special Survey, with dimensions to the mark G., and her main dimensions after the Bureau's rules are: Length between perpendiculars, 185 feet; breadth, molded, 34 feet; depth, molded, 15 feet, and the draft loaded being about 13 feet 6 inches. Her scantlings and other details are given on the plans and 'midship section. The fore-and-aft parts of the deck are raised, having a length of, respectively, 46 feet and 76 feet, and laid with Oregon pine, while the 'midship deck is bare steel. The bulwark is solid steel plate around the fore and 'midship decks, while stanchions and pipe rail are fitted aft. The machinery is placed aft, the sand bin 'midship and the living quarters forward, while the maneuvering bridge, with pilot house, is aft on top of the engine and boiler casing, and here also the boats are stowed. One light, seamless steel mast stepped on the fore deck, together with the rather huge smokestack-way aft, is the only rigging provided for. On the mast is arranged a crow's nest for lookout and commanding purposes, and also a light wooden derrick boom.

The machinery consists of a triple-expansion, reciprocating steam engine, indicating about 525 horsepower, and arranged for driving both propeller and sand pump. Steam is furnished by two Scotch boilers, 9 feet 8 inches long by 10 feet 3 inches diameter, with two furnaces each. In light condition on the trial trip the ship averaged 8.75 knots. The rotary sand pump is built of heavy steel plates and angles, with cast steel fittings of the company's own particular design, with the fan wings and other places subject to hard wear covered with special hard steel linings, and it has proved very successful through the trials passed. The suction pipes are two in number, one on each side of the ship, but only one being used at a time, 30 inches in diameter, and made of heavy seamless steel tubing without any stiffening whatever, and also without the hydraulic or spring shock absorber generally considered necessary; the pipe and its double-acting swivel connection to the ship's side being strong enough to resist all strains and stresses playing in.

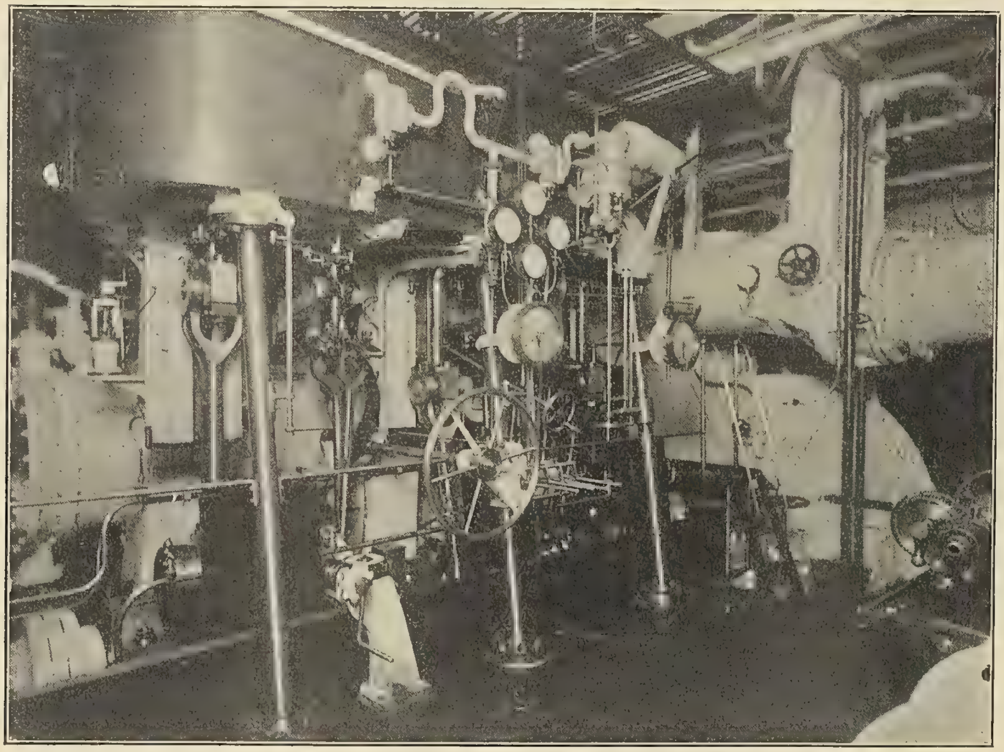


FIG. 1.—ENGINE ROOM OF DREDGE GRAADYB

The suction openings on both sides are below the waterline in order to lower the lifting height of the pump, and they are closed with sliding valves operated by hand-wheels and spindles, and so are the openings for the flow pipe connections, which are also 30 inches in diameter, and on both sides just above the light water-line. One of these huge valves can be seen in the view of the engine room, Fig. 1. The swivel couplings are made of cast steel, and their construction will be easily understood from Fig. 5. They are mounted on cast

steel shields sliding up and down in guides, and the pipes can thus be stowed on deck when the ship is under way, leaving only the guide tracks projecting outside the shell.

to the hopper room through rectangular, hand-operated, hinged valves, 24 by 15 inches, three on each side, as shown on the general arrangement plan and the 'midship section. There

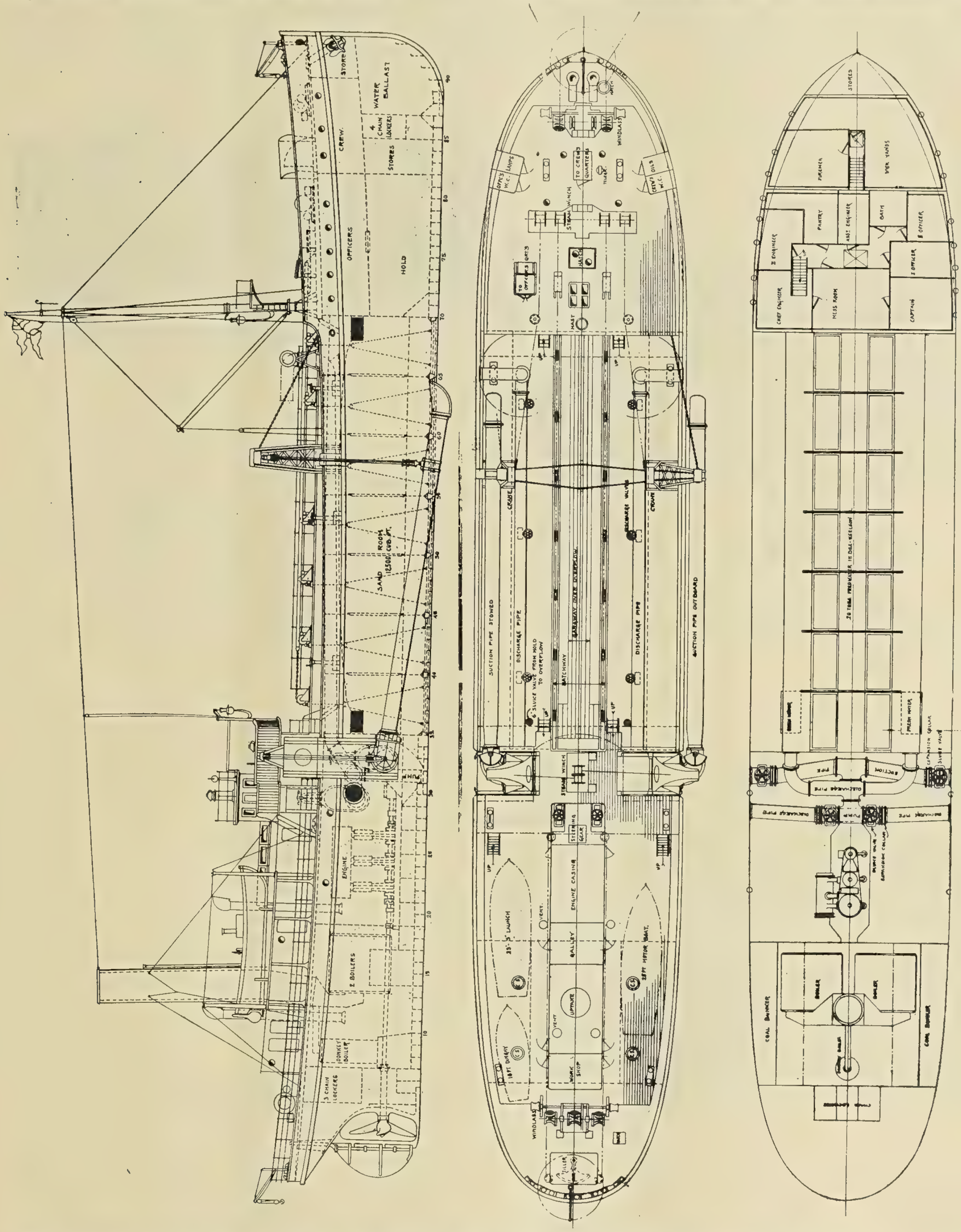


FIG. 2.—GENERAL ARRANGEMENT PLANS OF THE GRAADYB

The discharge pipes to the sand bin are also two in number, branched off from the top of the pump and are used simultaneously. They are 24 inches in diameter, made of seamless steel tubing and laid on top of the deck amidship as far outboard as practical, and opening down through the deck is no valve between these pipes and the pump, the forward ends acting as reserve height for the pump. In the engine room is also installed an independent reciprocating water pump connected to a 3-inch pipe system for washing out the sand bin and the sand pipes, the valves and main pump.

The hold is arranged as one continuous sand bin, 69 feet 6 inches in length and of 2,500 cubic feet capacity, with sloping sides as ordinary. The box keelson is utilized as a feed-water tank, and on both sides of it are seven hopper doors, 9 feet 3 inches by 4 feet 3 inches, made of steel plate with angle-bar frame and sheathed with yellow pine on upper and lower sides. The doors are hinged outboard, and the hinges are brought up well clear of the ship's bottom. The closing of the hopper doors is done in the good old Dutch way by chains from their inboard edges, two from each door brought together on a compensation link from which single chains lead up over heavy cast steel rollers on top of the hatch coaming. The chains are then connected to two channel bars running longitudinal on both sides of the rollers. These channel bars are worked by the forward maneuvering winch through a fixed purchase with steel wire ropes. Just below the rollers is a solid steel link fitted in the single chains with a rectangular hole in it for locking the hopper doors by means of a steel wedge resting on the hatch coamings. This arrangement relieves the strain from the winch and purchase when doors are closed, and also allows the doors to be worked independently.

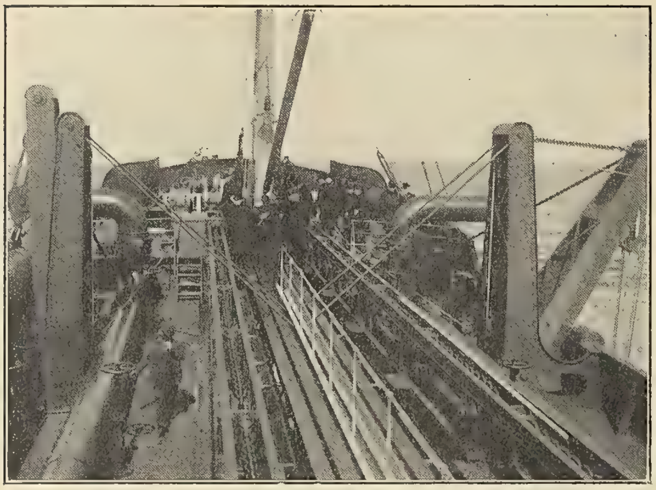


FIG. 3.—DECK VIEW LOOKING FORWARD

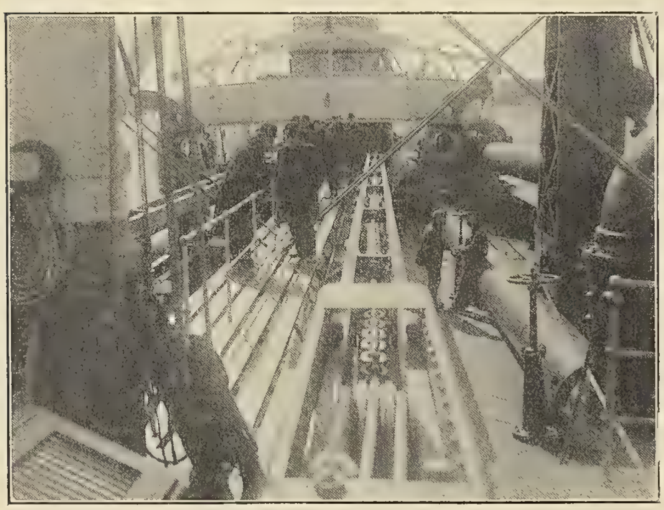


FIG. 4.—DECK VIEW LOOKING AFT

Over the whole length of the hold is a hatch opening, 8 feet 9 inches wide, with solid steel coaming, the upper edge of which is parallel to the keel; inside the coaming is arranged a steel girder 24 inches deep, which together with the coaming proper carries the chain rollers as before mentioned. Two feet below the top of the coaming is the top of the overflow, arranged as a kind of a trench in the center of the ship, running the full length of the sand bin and slooping down at both ends to transverse conducts, which lead the overflow water overboard through big rectangular holes in both ends of the hold and on both sides of the ship below the main deck. A gangway is arranged over the overflow trench between the hatch coamings for access to the wedge locks.

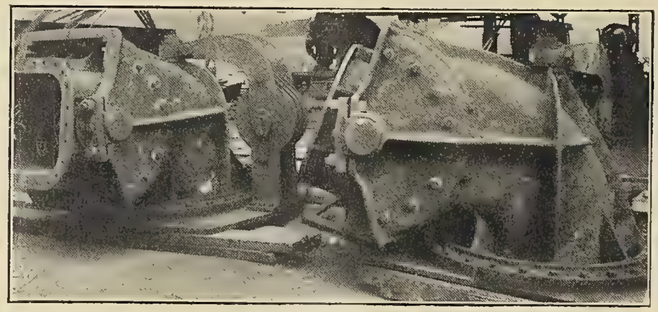


FIG. 5.—SWIVEL COUPLINGS ON SUCTION OPENINGS

There is a maximum head of about 2 feet 9 inches and a minimum of about 1 foot 9 inches from the lower edge of the discharge valves to the top of the overflow, which together with the transverse distance of about 8 feet provides ample time and conditions for the sand to settle down before the overflow is reached, and, as before said, this arrangement is giving an almost sand-free overflow. It will also be seen that the deck is kept entirely free from the overflow water. When the sand bin is filled and the pump is stopped the water standing on top of the sand will drain overboard back through the pump, and a 6-inch sluice valve to the aft transverse overflow is also provided for this purpose. When the pump is to discharge through flow pipes, the six hold discharge valves are kept closed and the one side discharge valve in the engine room opened. For loading into barges through the forward swinging ends of the main discharge pipes all the valves are simply kept closed.

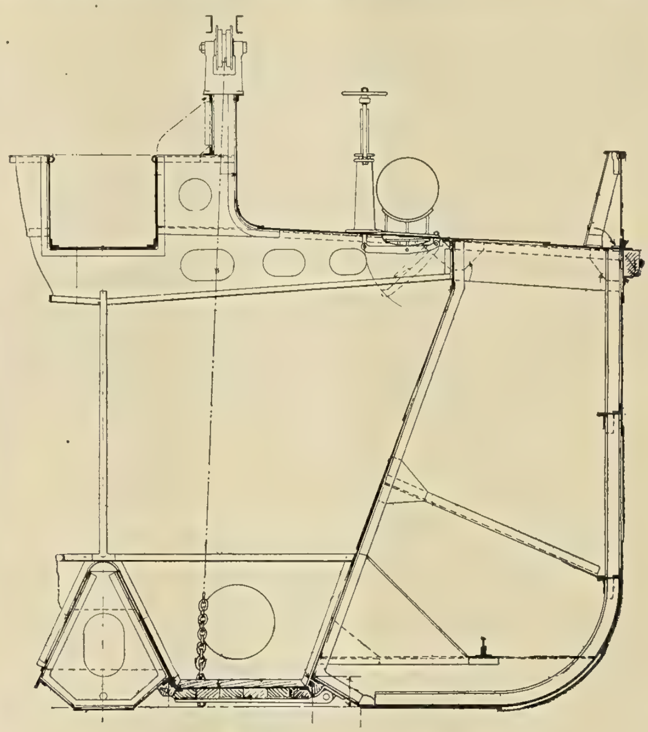


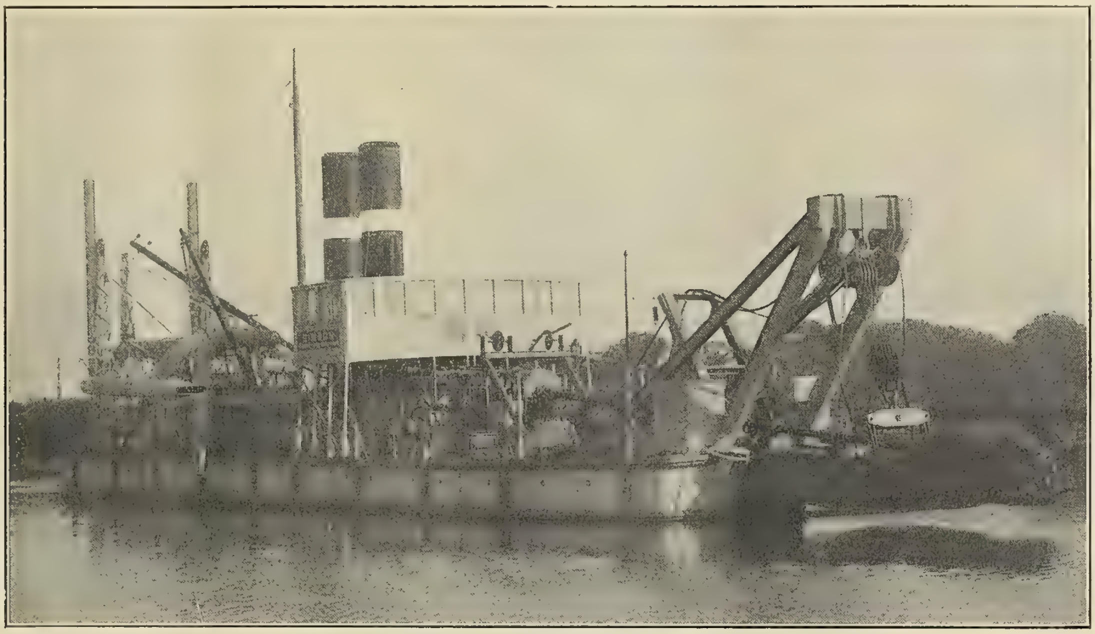
FIG. 6.—SECTION THROUGH HOLD

The deck machinery for handling the suction pipes is very complete and substantial. The pipes are about 63 feet long from the center of the shell hole to the tip of the nozzle, and are designed for a normal depth of dredging of 40 feet below the waterline. Two cranes for each pipe, one forward and one aft, are provided for raising the pipes and sliding them in on the deck. Figs. 3 and 4 showing one pipe stowed on deck and the other one working outboard give an idea of their general arrangement. The forward one is a tipping crane built of plates and channel bars, and so arranged that it will tip inboard and swing the pipe on deck automatically when the lower purchase block mounted on the pipe is up and caught by the big hooks seen suspended from the upper purchase block. The steel wire hoisting rope leads over pulleys to the steam winch on fore deck, the same that operates the hopper doors, as before mentioned. Double chains between the tops of the swinging and the fixed legs of the crane stop it in the outboard position, and another chain from the top of the swinging leg and fixed well forward acts as side guy. The after cranes are also built of plates and angles, and operated both by hand and by an independent steam winch on the deck right behind the cranes. As will be seen from the plans and Fig. 6 its outboard side forms a continuation of the tracks for the swivel coupling with a neck projecting out over it, bearing fixed sheaves for the lifting purchase. On the shield bearing the swivel coupling are other sheaves fitted for the lifting wire rope which is worked by the steam winch. When the coupling is on top it is locked simply by inserting a pair of stop pins, and the whole crane is then rolled inboard on heavy cast steel tracks bearing teeth bars on their tops. Combined gear and bearing wheels are engaged in the teeth bars and worked by a single hand swing through a screw and worm gear.

The anchoring and warping machinery consists of a steam windlass forward, with two chain wheels for the bow anchors and two drums for the warping chains, which lead over heavy roller chocks on the plate bulwark in the bow and another steam windlass aft with three chain drums and rollers on the bulwark. An anchor crane is also fitted forward and aft, and under each windlass are ample chain lockers arranged. The rudder is worked by a steam gear placed on the main deck inside the engine casing and just below the wheel on the navigating bridge. The ship is lighted throughout by electricity, having also two arc lamps on deck for night work; the generator is installed down in the engine room.

Under the living rooms forward is a water ballast tank in the bow, then comes the forward chain lockers and stores, and right forward of the sand bin is a roomy hold with hatchways, and the derrick boom is arranged to fit on both sides of the mast, so that it can be used handling goods to this hold also.

The small boats, stowed aft on the casing top, are: One 16-foot dinghy, one 23-foot 3-inch launch with anchor-handling gear, and one 25-foot motor boat with crude oil motor.



DUTCH SUCTION DREDGE SIMSON

A Dutch Suction Dredge

A suction dredge with clay cutter was built in the year 1911 by the "Werf Conrad" Company, of Haarlem, Holland, for the Kölnische Tiefbau Gesellschaft for their works at Hamburg. This is one of the most powerful dredgers of its kind. It is arranged with a suction pipe in a central well, carrying a clay cutter for working to a depth of about 45 feet below water, but the piping arrangement can also be changed for working as a barge-unloading dredger.

The vessel, which is named the *Simson*, has the following dimensions: Length, 150 feet; width, 33 feet; depth at ship's sides, 12½ feet; mean draft in working order, 6½ feet.

The vessel is fitted with two triple-expansion engines of a total indicated horsepower of 1,000, each driving a powerful sand pump. These pumps can be arranged in parallel or in series, according to the distance to which the stuff is to be pumped. Besides these two there is one triple-expansion engine of 200 indicated horsepower driving a centrifugal water pump to be used when the dredge is used for emptying barges. The cutter engine driving the clay cutter is mounted on top of the ladder, and develops 200 indicated horsepower. A complete self-contained condensing plant, consisting of a surface condenser and a set of compound horizontal engines, driving all necessary pumps, takes the steam of all the above named main engines and also of all auxiliary engines, pumps, winches, dynamo engine, etc.

The handling of the dredge is absolutely centralized. It works on two spuds and two side lines, worked from one big four-barrel winch with heavy friction clutches and band brakes. The ladder is hung from a separate steam winch.

All handles for clutches, brakes, reverse gear and steam valves of these two winches are brought together in the pilot house. Here are also the necessary hand-wheels and handles for manipulating the cutter engine, telegraphs to the engine room and a complete set of pressure and vacuum gages for boilers, engines and suction and delivery of sand pumps. From this pilot house one man can easily work the whole dredge. Two marine boilers, having a total heating surface of 4,300 square feet, produce the necessary steam at a working pressure of 160 pounds per square inch.

This machine can easily dig and force ashore a quantity of 75,000 cubic yards per week, as has been proved in actual work. This quantity can, nevertheless, not be considered as a maximum, because a good many hours have been lost each week in adding or taking away floating sections of the discharge pipe line, which has been inevitable by the nature of the work.

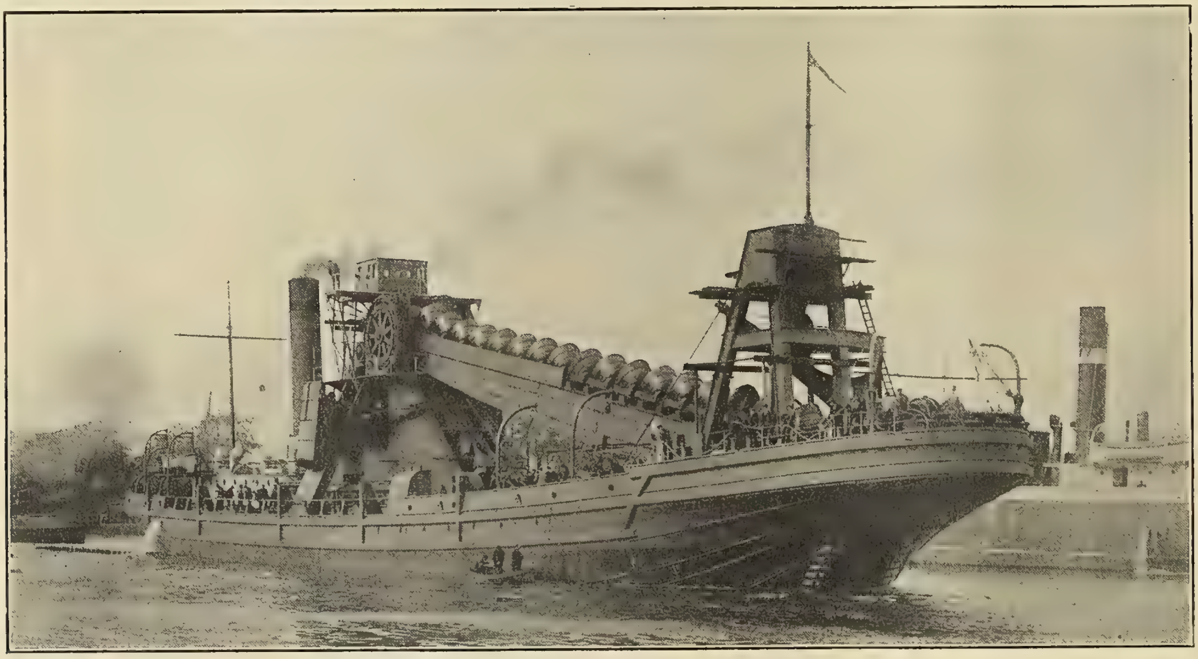
Two Large Canal and Harbor Dredgers

Messrs. William Simons & Company, Ltd., Renfrew, have just completed to the order of the Isthmian Canal Commission a dredger which will be employed on canal work of the very hardest description. The dredger, which is called the *Corozal,* is of the twin-screw type, and made the voyage to the Pacific Coast under her own steam. She has a hopper capacity for 1,200 tons dredging, and the bucket ladder is designed to dredge to a depth of 50 feet.

The dredger is propelled at a speed of 10 knots by two sets of triple-expansion surface condensing engines, supplied with steam from two cylindrical multi-tubular boilers, constructed to Lloyd's requirements for a working pressure of 180 pounds per square inch. A complete outfit of most modern auxiliary machinery is provided in the engine room, including independent air pumps, circulating pumps, feed pumps, feed heater and filter, etc.

The dredging gear is of massive description, and is arranged to give three speeds of buckets to suit the various kinds of material to be dealt with. The dredging gear can be driven by either of the main propelling engines. Two sets of buckets are provided, one of 54 cubic feet capacity for dredging soft material, and one of 35 cubic feet capacity for dredging stiff clay. The bucket ladder is a steel girder of exceptional strength, and an idea of the enormous strength of the bucket chain may be conveyed by the statement that the ladder, with its chain of buckets, links and pins, weighs upwards of 240 tons. The upper end of bucket ladder is supported on an independent pivot shaft, and the lower end is controlled by powerful steel wire rope tackle and an independent steam hoist gear, which is designed for raising the ladder at a speed of 10 feet per minute.

Steam maneuvering winches are fitted at the bow and stern, each driven by independent two-cylinder engines, and each barrel is fitted with friction clutch and brake to enable the mooring chains to work independently of each other, or simultaneously, as may be required. Shoots are provided for loading into the vessel's own hopper, and there are also overboard shoots controlled by independent steam winches for loading into barges alongside. The hopper doors are controlled by independent hydraulic gear.



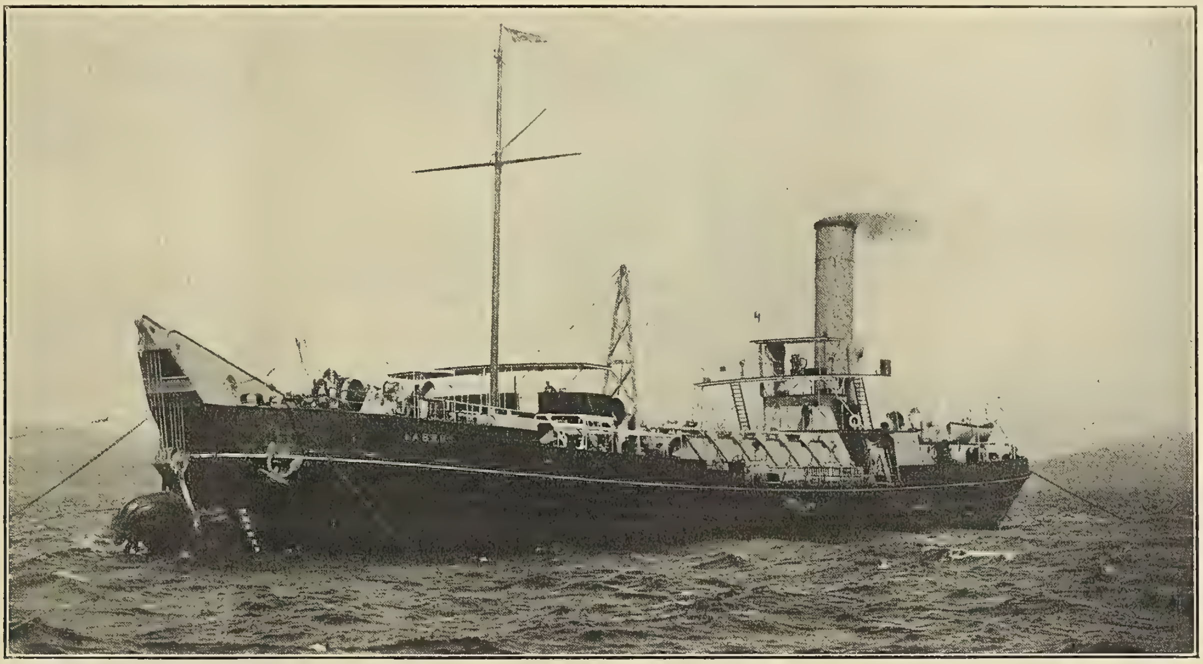
DREDGE COROZAL FOR THE ISTHMIAN CANAL COMMISSION

Steam steering gear, full electric light installation and refrigerating plant are provided, also cabins for officers and comfortable quarters for the crew and the most modern equipment for a vessel of this class.

In the prosecution of their project for the improvement of the depths in the Esplanade Channel, Durban Bay, and for the opening of new wharves on the west side of the bay, the Government of the Union of South Africa recently placed an order with Simons & Company for one of their "Simons" patent cutter suction hopper dredgers. This new dredger, named the *Labrus,* was delivered at Durban towards the end of last year. The bottom of Durban Bay, where the dredger is employed, is composed almost wholly of clay of a very hard nature. The dredging of this character of material by means of a spiral rotary cutter is only a recent development in dredge building, the first hopper dredger of this type being

the Simons dredger *St. Lawrence*, constructed recently to the order of the British Admiralty.

The *Labrus*, a photograph of which is reproduced on this page, is a twin-screw hopper vessel of 2,000 tons carrying capacity. Two sets of triple-expansion, surface condensing engines are fitted aft for propelling the vessel at a speed of 10 knots, and there is an independent set of triple-expansion engines for driving the dredging pump, with a complete installation of auxiliary machinery in a separate engine room immediately in front of the hopper compartment. Steam for the propelling and pumping engines and all machinery throughout the dredger is supplied by three large marine type steel boilers.



TWIN-SCREW HOPPER DREDGE LABRUS

The dredging pump is of the most massive and powerful description to withstand any shocks which may be sustained when dredging in clay mixed with stones. The suction pipe is carried on a girder led through a well forward, and is of sufficient length to enable dredging to be done at a depth of 45 feet below the waterline. The dredger has also been designed for cutting its own flotation.

The cutter at the mouth of suction pipe is driven through a line of shafting, fitted on the upper side of the suction frame, and by machine-cut steel gearing actuated by a set of powerful independent compound condensing engines. In addition to the usual winches for mooring from the deck at the bow and stern a special winch is placed amidship from which the moorings are led along the suction frame to fair leads at the lower end.

The hopper is fitted with Simons patent arrangements, whereby the contents of the hopper can be discharged either through the doors in the ordinary way or over-side by the pump for land reclamation. In addition to loading into its own hopper the vessel is arranged to discharge into barges moored alongside or through a pipe line.

The Howden system of forced draft for steam boilers, as developed by Messrs. James Howden & Company, Ltd., of Glasgow, is well known to marine engineers, but its application to the power plants of dredges is a development that is sometimes overlooked. Where dredging machines are kept constantly at work a saving in fuel consumption is essential.

Electrical Operation of Dredges

BY H. W. RODGERS

Although not an entirely new field for electrical enginnering, still there are so few motor operated hydraulic-suction dredges in existence that mention of the 20-inch dredge, owned and operated on the New York State Barge Canal, at Fairport, N. Y., by the H. S. Kerbaugh Company, may be of interest.

This dredge is equipped with a centrifugal pump, having a capacity of 600 to 700 cubic yards an hour, driven by a 700-horsepower, 375 revolutions per minute, 2,200 volts, 25 cycle, three-phase induction motor. The control apparatus consists of a drum controller, which handles the secondary current of the motor only, and an iron grid heavy duty starting rheostat, the primary being taken care of by means of an automatic oil switch.

The cutter machinery is driven by a 200-horsepower, 500 revolutions per minute, 2,200-volt, three-bearing induction motor, geared direct through a slip-friction clutch, the control consisting of a reversible drum controller with starting resistance.

For raising and lowering the spuds, the cutter head, and operating the head lines, a six-drum winch is used, driven by a 75-horsepower, 500 revolutions per minute, 2,200-volt, variable speed, three-bearing motor, controlled by a reversible-drum controller and rheostat of sufficient resistance to permit of 75 percent speed reduction.

In addition to the above there are two 25-horsepower, 1,500-K.-2,200-volt motors driving service pumps, one 10-horsepower, 750-K.-2,200-volt motor, driving a vacuum pump, two 5-horsepower, 1,500-K.-2,200-volt vertical motors, driving bilge pumps and a 10-kilowatt 2080/110-volt transformer for lighting purposes. This transformer also furnishes power for a 1.5-kilowatt motor generator set, used in connection with the searchlight on the bow of the dredge.

The switchboard, consisting of one incoming-line panel and three feeder panels, together with the starting compensators for the constant speed motors, are placed in the stern of the dredge, where the shore cable from the transformer barge enters at a tension of 2,300 volts.

Power is supplied by the Rochester Railway & Light Company, at a tension of 16,500 volts over a fifteen-mile transmission line, paralleling the canal, and stepped down to 2,300 volts through three 250-kilowatt transformers located on the barge which follows astern of the dredge.

The transformer barge is of heavy wooden construction, housed to protect the apparatus from the weather and, in addition to the transformers, contains suitable lightning arresters, choke coils and primary oil switch. Connection between the transformer barge and the transmission line is made by means of three flexible insulated cables, each cable being equipped with a shoe for sliding along the transmission line, the interaxial distance between conductors being maintained by a triangular insulated spreader. Between the barge and the dredge a 600-foot, three-conductor, 2,300-volt, stranded, weather-proof, armored cable is used, which permits of considerable range of operation without shiftng the connections between transformer barge and transmission line, and it might be both advisable and desirable to use a three-conductor armored cable of similar construction between the transmission line and the transformer barge, owing to the increased range of operation and decreased time required to make change in connections.

In comparison with the steam dredge, the electric equipment is much cleaner, more compact and can be operated a greater number of hours per month, owing to the short time required for cleaning and overhauling on account of the reliability of the machinery.

The cost of operation may be greater or less, depending upon the cost of electrical power as compared with the cost of coal and water, but it should be remembered that the initial cost, repairs and labor, are considerably less on the electric dredge than on the steam dredge.

In some localities the question of boiler feed water is a serious problem, and unless an elaborate filtration plant is installed at considerable expense, the delays caused by frequent cleaning of boilers becomes serious.

At the present time, with the numerous electric power plants throughout the country, and the facilities for transmitting large amounts of power through great distances, it is safe to assume that the electrical operation of this class of machinery is possible in any locality, and from the results already obtained it is evident that the electric dredge has come to stay.

The electrical equipment on the dredge described above was furnished by the General Electric Company, Schenectady, N. Y.

A German Frühling Dredge

One of several powerful suction dredges, built on the Frühling system, of which the Schichau Company, Elbing and Dantzig, have the exclusive rights in Germany, is the *Pumpenbagger III.*, which this company built for service at Emden. The vessel is 164 feet long, 33 feet 9½ inches beam and 11 feet 9½ inches draft. Reciprocating engines of 700 indicated horsepower, driving twin screws, give the vessel a speed of 9 knots. The total capacity of the holds is 17,660 cubic feet.

The Frühling system of suction dredging has been described in detail in the May, 1909, and May, 1911, issues of International Marine Engineering. In these dredges aft of the engine room the vessel has a channel or well, forming twin sterns. In this well is the dredge suction arm, in which are incorporated the suction pipes and pressure water pipes. The girder arm is supported at the forward end by heavy cast steel pillow blocks, and at the lower end of the girder is a pair of hinges by which the bucket head is attached. The head is practically a huge inclosed rake serrated along the edge with sharp cutting teeth, through the incisors of which is ejected high-pressure water to aid in disintegrating the spoil and make it of suitable consistency to be sucked through the suction pipes into the pumps, whence it is deposited into the hoppers of the vessel.

FRÜHLING DREDGE PUMPENBAGGER III., BUILT BY SCHICKAU AT ELBING

Design and Mechanical Features of the California Gold Dredge.

At a combined meeting of the American Society of Mechanical Engineers and the American Institute of Mining Engineers, held in New York, Feb. 13, a paper on the above subject was read by Mr. Robert E. Cranston. The first California dredge, built in 1897-1898, was patterned after the New Zealand type, and the present California type dredge is a combination of this type and several others. The buckets are made with cast steel base, pressed steel hood and manganese steel lip. The lower tumbler is a six-sided steel casting with renewable wearing plates over which the buckets pass. They then travel up a structural steel ladder on rollers and over a six-sided upper tumbler which is driven by a chain of cast steel gears. The buckets dump their material into a hopper which discharges into a shaking or revolving screen. The fine material goes through onto gold-saving tables, and the coarse material is stacked aft of the dredge by means of a belt conveyor. The dredge is held in place by steel spuds and moved by means of side lines running to a motor-driven winch. The digging ladder is raised by means of a separate winch.

Battleship Florida, the Latest United States Dreadnought

BY HENDERSON B. GREGORY

The *Florida,* built at the navy yard, Brooklyn, N. Y., is one of two battleships authorized by an Act of Congress approved May 13, 1908, the sister ship being the Utah, built by the New York Shipbuilding Company, of Camden, N. J.

The vessel was designed for a speed of 20.75 knots, with the main turbines developing 28,000-shaft horsepower and at a displacement of 21,825 tons, a performance which was easily attained, as shown by the trial data given later.

Principal Hull Data

Like all recent battleships, the Florida is of the familiar all-big-gun type, with principal dimensions, as follows:

Length between perpendiculars, feet and inches	510-00
On L.W.L., feet and inches	510-00
Over all, feet and inches	521-06
On straight keel, feet and inches	460-00
Projection forward of F.P., feet and inches	11-06
Aft of A.P., feet and inches	0-00
Breadth, extreme, at L.W.L., outside of armor, feet and ins.	88-02⅝
Molded, feet and inches	87-10¼
Depth, molded, main deck at side M.S., feet and inches	44-05⅞
Draft to L.W.L., feet and inches	28-6
Corresponding displacement, tons	21,825
Ratio of length to beam	5.781
Displacement per inch at L.W.L. tons of S.W., tons	73.82
Area of midship section, square feet	2,458
L.W.L. plane, square feet	31,056
Wetted surface, square feet	56,700
Coefficient of fineness, block	.5837
Length of fire-room space, feet and inches	102-00
Engine-room space, feet and inches	60-00

Anchor Windlass

The anchor windlass is of the Williamson Bros. horizontal type. It has two vertical shafts driven by gearing from a horizontal shaft coupled to the engine crank shaft. Each vertical shaft carries on its upper end, above the forecastle deck, a wildcat and locking gear complete. The wildcats can be operated together or independently. The windlass engine is a double-horizontal engine, the cylinders being 16 inches in diameter and the stroke 16 inches.

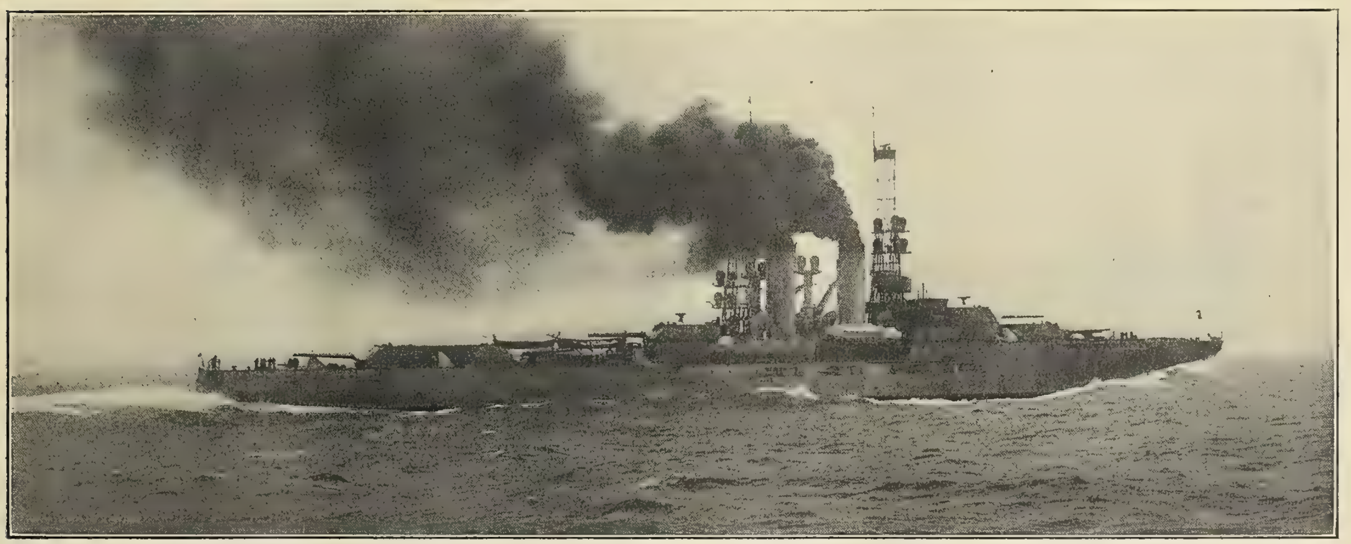
Steering Gear

The steering gear consists of a right and left-handed screw, connected through nuts and links to the crosshead on the rudder stock. This gear is connected through a line of shafting and gears to the steering engine, located in a separate compartment immediately aft of the starboard engine room.

The steering engine is a vertical double engine, with cylinders 17 inches diameter by 14 inches stroke, built by Williamson Bros. It is controlled from the various steering stations by wire-rope transmission or the telemotor; also by a handwheel in the steering engine room.

Four large wheels for hand steering are located in the hand-steering room. Suitable clutches are provided for disconnecting this gear when not in use, which is also the case with the steering engine.

The rudder is of the usual balanced type.



(Photograph by N. L. Stebbins.)

FIG. 1.—UNITED STATES BATTLESHIP FLORIDA RUNNING AT A SPEED OF 22.06 KNOTS

Battery

The main battery consists of ten 12-inch rifles arranged in pairs in five turrets on the center line of the vessel. Turrets Nos. 1 and 2 are on the forecastle deck, the latter being elevated so as to fire over the top of the former. Turrets Nos. 3, 4 and 5 are located on the main deck abaft the smoke pipes. Of this group Turret No. 3 is elevated and Nos. 4 and 5 are placed back to back at a lower level, well astern of the former.

A secondary battery of sixteen 5-inch rapid fire guns is also provided, together with the following smaller guns:

Four 3-pounder saluting guns.

Two 1-pounder semi-automatic guns for boats.

Two 0.30-inch machine guns for boats.

Two 3-inch field pieces.

There are also two 21-inch submarine torpedo tubes.

Coaling Engines

There are two vertical double-cylinder coaling engines, located on the gun deck, port and starboard. The cylinders are 9 inches diameter by 9 inches stroke. Each engine drives, through miter gears, a shaft running fore and aft, to which are geared five winch heads, which are thrown in or out of gear by clutches. The shafts are cross-connected by a shaft and gears, so that either engine can operate all winch heads if necessary.

Ventilation

The various compartments and living quarters are artificially ventilated on the plenum system, by 32-motor driven fans located at convenient points throughout the vessel.

Heating System

The staterooms, quarters and crew's spaces are heated by the ventilating system, steam coil thermo-tanks being introduced in the air ducts for heating the air supplied these spaces. The thermo-tanks can be cut out when desired.

All other parts of the vessel to be heated are provided with the usual pipe-coil radiators.

Main Engines

The propelling machinery consists of Parsons turbines, designed to run at 330 revolutions per minute, when developing 28,000-shaft horsepower. They are arranged on four lines of shafting, as shown in sketch, Fig. 2. The arrangement provides six ahead and four astern turbines, each low-pressure turbine embodying an astern turbine in the after end. For ahead motion the outboard shafts are driven by the main high-pressure turbines, and the inboard shafts by the low-pressure ahead turbines alone, or in combination with the intermediate-pressure and high-pressure cruising turbines, as described in the following paragraphs.

Four turbines only are used for full speed ahead, steam being admitted to the main high-pressure turbines and expanded through the low-pressure ahead turbines into the condensers. Under this condition the astern and cruising turbines revolve idly in a vacuum, which is maintained through the drain connections.

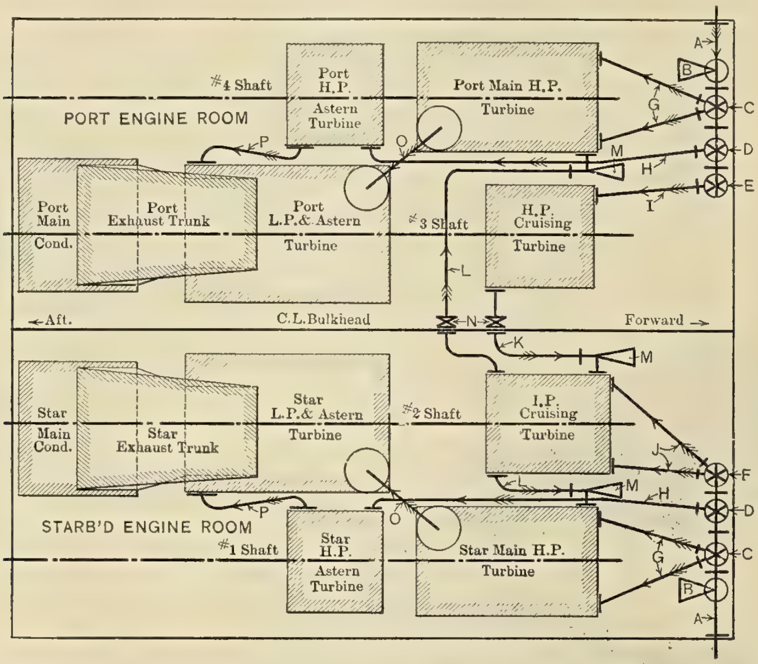
When cruising at low speed all six of the ahead turbines are used, steam being admitted to the high-pressure cruising turbines and expanded successively through the intermediate-pressure cruising turbine, main high-pressure turbines and the low-pressure ahead turbines, exhausting into the condensers; the astern turbines again revolving idly in a vacuum.

For high-cruising speeds only five turbines are employed, steam being admitted to the intermediate-pressure cruising turbine, thence through the main high-pressure and low-pressure ahead turbines, exhausting into the condensers; the remaining turbines revolving idly in a vacuum.

For astern motion all four astern turbines are used. The outboard shafts are driven by the high-pressure astern turbines and the inboard shafts by the low-pressure astern turbines, steam being admitted to the former and expanded through the latter into the condensers. Under this condition all ahead turbines revolve idly in a vacuum.

Self-closing valves are fitted in the receiver pipes between the high-pressure and intermediate-pressure cruising turbines, and between the intermediate-pressure cruising and main high-pressure turbines, as shown in Fig. 2, to prevent back flow of steam when changing from the low to high speed cruising combination or from high cruising to full speed conditions. The turbines are controlled from the working platform, where the regulating valves for admitting steam to the different turbines are located.

There is a main bearing at each end of each turbine for carrying the rotor. Each turbine, except the high-pressure astern, is provided with a thrust block at the forward end, consisting of a number of brass rings, in halves, fitting into corresponding collars on the shaft. The lower half of each ring is for taking the ahead and the upper half the astern thrust.



MARKS	DESCRIPTION OF PART
A	14" Main Steam from Boilers
B	14" Engine Stop and Governor Valve
C	14" Regulating Valve, M.H.P. Turbine
D	13" " " , H.P. Astern "
E	10½" " " ,H.P.C. "
F	14" " " ,I.P.C. "
G	10½" Steam to M.H.P. Turbine
H	13" " " H.P. Astern "
I	10½" " " H.P.C. "
J	10½" " " I.P.C. "
K	17" Steam from H.P C. to I.P.C.
L	17" " " I.P.C. to M.H.P.
M	17" Self-Closing Valve
N	17" Cut-out Valve
O	43" Steam from M.H.P. to L.P. Ahead
P	29" " " H.P. Ast. to L.P. Ast.

FIG. 2.—SKETCH SHOWING ARRANGEMENT OF MAIN ENGINES AND PIPING

All the main bearings, thrust bearings and line-shaft bearings are provided with a closed system of forced lubrication. A Proell governor is fitted to each line of shafting, the governor mechanism operating the main steam stop valves in the engine room. Each line of shafting has an electrically operated turning gear, consisting of a 5-horsepower, reversible Diehl motor, which engages through gears and worm wheel on the main shaft. Provision is also made for turning by hand with a ratchet.

Main Turbine Data

Motor drums:	Diameter.	Length.
Main H.P., inches	71	114
H.P. cruising, inches	71	63½
I.P. cruising, inches	70	72½
L.P. ahead, inches	97	87⅝
H.P. astern, inches	71	36¼
L.P. astern, inches	71	44⅛

Number of expansions:	
Main H.P. and L.P. ahead, each	6
H.P.C. and I.P.C., each	3
H.P. astern and L.P. astern, each	4

Turbine casings, diameter, inches, each expansion:	
Main H.P.	73¼, 74¼, 75½, 77½, 80, 83½
L.P. ahead	107½, 111½, 117½, 128, 128, 128
H.P.C.	72¼, 72⅝, 73⅛
I.P.C.	72½, 73¼, 74¼
H.P. astern	72¾, 73¾, 75, 77
L.P. astern	80, 83½, 83½, 83½

Length of casing for each expansion and diameter noted above:	
Main H.P., inches	17¼, 17, 17 13/16, 18⅝, 19½, 24 9/16
L.P. ahead, inches	12 13/16, 13, 15 3/16, 19, 19, 19
H.P.C., inches	18½, 18½, 25¾
I.P.C., inches	23½, 23½, 24⅜
Length of casing for each expansion and diameter noted above:	
H.P. astern, inches	9¼, 8¾, 8¾, 9
L.P. astern, inches	9¾, 11 25/32, 11 25/32, 11 25/32
Rows of blading for each expansion:	
Main H.P.	13
L.P. ahead	3 of 7, 3 of 6
H.P.C.	20
I.P.C.	18
H.P. astern	6
L.P. astern	5
Length of blades for each expansion, inches:	
Main H.P.	1⅛, 1⅝, 2¼, 3¼, 4½, 6¼
L.P. ahead	5¼, 7¼, 10¼, 13½, 13½, 13½
H.P.C.	⅝, 13/16, 1 1/16
I.P.C.	1¼, 1⅝, 2⅛
H.P. astern	⅞, 1⅜, 2, 3
L.P. astern	4½, 6¼, 6¼, 6¼

Rotor shaft and bearings:	Length, Inches.	Diameter, Inches.	Diam. Axial, Inches.	Length Over All of Rotor Drum and Shaft, Feet and Inches.
Main H.P.	18¼	14	9	21-07¼
L.P. ahead	29	15	11	25-10¾
H.P.C.	14½	14	11	15-02¾
I.P.C.	14½	14	11	16
H.P. astern	12½	14	9	11-02¾
L.P. astern	29	15	11	With ahead.

Thrust bearings:	M.H.P. Each.	L.P. Ahead. Each.	H.P.C.	I.P.C.
Collars on shaft, number	17	17	8	8
Thickness, inches	¾	¾	¾	¾
Distance between, inches	1 1/16	1 1/16	1 1/16	1 1/16
Outside diameter, inches	17¾	17¾	17¾	17¾
Inside diameter, inches	12½	12½	12½	12½
Number of shoes, top	16	16	7	7
" " bottom	17	17	8	8

Shafting

There are four lines of shafting, a pair port and starboard, respectively. Each pair is parallel in itself, but diverges from the center of the vessel and slopes downward aft. The outboard shafts are in two sections each, consisting of one line shaft, supported by a spring-bearing and a propeller shaft, extending through the stern tube and supported by the strut and stern tube bearings. The inboard shafting is in four sections each, there being two line shafts supported by three-spring bearings, one stern tube shaft, carried by the stern tube bearings, and a propeller shaft supported by one strut bearing.

All stern tube and strut bearings are ligum vitae lined and the shafts are composition-bushed at these bearings. The shafting within the stern tubes is covered with a composition casing. The inboard coupling consists of a sleeve secured by four keys to the stern tube shaft. Back of the sleeve is a collar made in halves and secured to the sleeve and to the coupling disk on the line shaft by fitted bolts. The outboard coupling is of the split-sleeve type, consisting of two half sleeves secured to each shaft by two keys; the half sleeves being secured together by bolts.

Shaft Data

Line shafts, diameter outside, inches	12⅛
Axial hole, inches	6
Stern tube shafts, diameter outside, inches	12⅜
Axial hole, inches	6
Propeller shafts, diameter outside, inches	12⅜
Axial hole, inches	6
Couplings, diameter, inches	22
Thickness, inches	3
Inboard coupling, diameter of sleeve outside, inches	22½
Inside, inches	14⅛
Length of sleeve, inches	12
Thickness of collars, inches	2⅜
Coupling bolts, number each coupling	8
Diameter (taper)* at face of coupling, inches	2⅜
Outboard coupling, length of half sleeves, inches	48
Bolts securing sleeves, number	16
Diameter, inches	1¾
Spring bearings, diameter, inches	12⅛
Length, inches	18
Forward stern tube bearings, diameter, inches	14⅝
Length, inches	49½
After stern tube bearings, diameter, inches	14⅝
Length, inches	60
Strut bearings, diameter, inches	14⅝
Length, inches	72

* Parallel bolts for inboard coupling.

Propellers

There are four three-bladed propellers, all outboard turning when going ahead. The blades and hubs are of monel metal and cast in one piece. The blades are true-screw machined to pitch.

Propeller Data

Diameter of propeller, inches	110
Hub, inches	27
Pitch, inches	102
Ratio of diameter to pitch	1.08
Area, projected, square inches	5,307
Helicoidal, square inches	5,841
Disk, square inches	9,503
Ratio, projected to disk area	0.56
Helicoidal to disk area	0.61

Main Condensing Apparatus

Main Condensers.—There is one main condenser in each engine room of the following principal dimensions:

Inside diameter, feet and inches	10-0
Thickness of shell (steel), inches	½
Length between tube sheets, feet and inches	11-0
Thickness of tube sheets, inches	1
Number of tubes	8,466
Diameter of tubes, inches	⅝
Thickness of tubes, B. W. G.	No. 16
Cooling surface, square feet	15,235
Exhaust nozzle, square feet	48
Diameter of air pump suction, inches	12
Diameter of augmenter suction, inches	15
Diameter of circulating water inlet and outlet, inches	30

Vacuum Augmenter.—In order to obtain the maximum possible vacuum, so essential to efficient operation of turbine

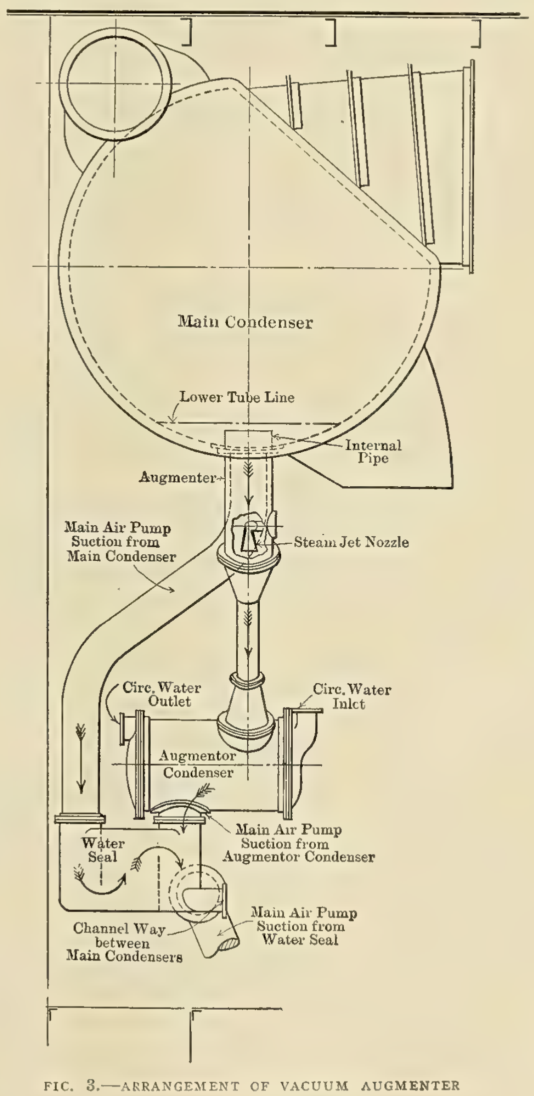


FIG. 3.—ARRANGEMENT OF VACUUM AUGMENTER

machinery, a Parsons vacuum augmenter is installed for each main condenser. It consists of a small condenser of 450 square feet cooling surface, placed below and connected to the main condenser by a pipe having a conical contracted portion,

through which a jet of steam is forced. This pipe extends about 6 inches into the main condenser shell, which prevents the water of condensation from entering it. The steam jet exhausts most of the air and vapor from the condenser and delivers it to the air-pump suction via the augmenter condenser. A water seal is placed in the air-pump suction, between the suction from the augmenter condenser and that from the main condenser, which prevents the air and vapor thus removed from returning to the main condenser. Fig. 3 shows a sketch of this apparatus.

Main Air Pumps.—An air pump, of the M. T. Davidson vertical, twin, bucket, single-acting type, is provided for each main condenser. The steam cylinders are 17½ inches diameter and the water cylinders 35 inches diameter, with a common stroke of 21 inches. The suction nozzle is 12 inches and the discharge nozzle 10 inches.

Main Circulating Pumps and Engines.—There is one centrifugal circulating pump for each main condenser, driven by a compound engine. The principal dimensions of pump and engine are as follows:

Capacity of pump, gallons per minute	15,000
Diameter of suction nozzle, inches (2)	21
Discharge nozzle, inches	30
Impeller, inches	51
H.P. cylinder, inches	11½
L.P. cylinder, inches	23
Stroke, inches	12

Feed and Filter Tank

A feed and filter tank of 4,000 gallons capacity is located at a high level in the forward inboard corner of each engine room. The filter chamber is in the top of the tank and has a capacity of about 700 gallons. The filter has an inner bottom of loose perforated plates and is divided into compartments, in which is placed the filtering material, by vertical division plates. These partitions are so arranged that the water, in passing through the filter, will flow under and over in succession.

Engine Room Auxiliaries

Auxiliary Condensers.—In each engine room there is an M. T. Davidson auxiliary condenser of 720 square feet cooling surface, connected through the auxiliary exhaust pipe to all the auxiliary machinery. Each condenser has an 8-inch by 10-inch by 12-inch by 12-inch horizontal, double-acting, single combined air and circulating pump.

Feed Water Heater.—A feed water heater of the Alberger Condenser Company's type, complete with all the necessary fittings, is located in each engine room. Each heater has a heating surface of 900 square feet. They are of the triple-flow type and located on the discharge side of the main-feed pumps. The heating agent is the exhaust steam, a back pressure being kept on the auxiliary exhaust line for this purpose by means of a spring relief valve at each condenser connection, opening toward the condenser.

Main Feed Pumps.—Two 14½-inch by 9½-inch by 18-inch main-feed pumps of the vertical, double-acting, single type are located on the forward bulkhead in each engine room. The pumps have suctions from the main feed tanks and discharge to the boilers through the feed water heaters or by passing same.

Fire and Bilge Pumps.—Two 12-inch by 10-inch by 18-inch vertical, double-acting, single, fire and bilge pumps are provided in each engine room. They are arranged to draw water from the bilge, drainage system and sea, and discharge to the fire main, sanitary system and overboard.

Pumps for the Forced Lubrication System.—One 8-inch by 7-inch by-8-inch, and two 10-inch by 9-inch by 12-inch, vertical, double-acting, single pumps are provided in each engine room for the forced lubrication system. The former is for circulating cooling water through the oil cooler and the latter for forcing the oil through the system. The oil pressure carried is about 10 pounds per square inch.

Fuel Oil Pumps.—There are two such pumps furnished, one located in each engine room. They are 10-inch by 7-inch by 12-inch, vertical, double-acting, single pumps, arranged to draw oil from the storage tanks and discharge same to the oil burners at the boilers.

Pipe Insulator Pumps.—In each engine room is a 6-inch by 8-inch by 8-inch, vertical, double-acting, single pump for circulating water around the main steam pipe flanges at bulkheads near magazines, to prevent the transmission of heat through the ship's structure to the magazines.

Boilers

The boilers, twelve in number, are of the Babcock & Wilcox watertube type, arranged in batteries of four each in three separate watertight compartments. They are designed to run the entire machinery installation at full power, with an average air pressure in the ash pits of not more than two inches of water. The uptakes are of the usual design and there are two smoke pipes, each about 92 feet in height above the grates and 11 feet 6 inches in diameter.

Boiler Data

Number	12
Working pressure, pounds per square inch	200
Test pressure, pounds per square inch	300
Height to top of drum, feet and inches	13-10¼
Length on floor, feet and inches	9-1½
Width on floor, feet and inches	18-4½
Drum, diameter, inches	42
Length, feet and inches	19-0¾
Thickness, inches	21/32
Number of furnaces, each boiler	1
Number of furnace doors, each boiler	5
Grates, length, feet and inches	7-0
Width, feet and inches	17-0
Total grate surface, square feet	1,428
Total heating surface, square feet	64,234
Ratio G.S. to H.S	44.98
Number of tube sections, each boiler	31
2-inch tubes, each boiler	1,100
4-inch tubes, each boiler	62
Distance between headers, feet and inches	8-0
Area of each smoke-pipe, mean, square feet	101.56
G.S ÷ area through smoke-pipe	7.03
Kind of forced draft	Closed fire-room
Number of oil burners, each boiler	8

Fuel Oil System

In addition to the usual coal burning appliances, a complete oil-burning system is provided, consisting of the necessary pumps, tanks, oil heaters and piping. Each boiler is fitted with eight oil burners, mechanically atomized, of the Peabody type. This installation is not intended for regular use, but only as an auxiliary to the coal.

Forced Draft Blowers

Four forced draft blowers are installed for each fire room. They are located in specially constructed blower rooms, just below the protective deck and above the center of each fire room. The fans are of the Sirocco type, built by the American Blower Company, and each is driven by a Diehl motor, controlled from the fire room working level or the blower room at will. Air is supplied from the fire room ventilators, which are closed at the bottom when under forced draft. The fan data is as follows:

Revolutions per minute	695
Horsepower, each	40
Fan, diameter, inches	33
Width, inches	30
Number of blades	64

Fire Room Auxiliaries

Auxiliary Feed Pumps.—There are three 14½-inch by 9½-inch by 18-inch auxiliary feed pumps, one in each fire room. They are of the vertical, double-acting, single type and are arranged so that any pump can feed any boiler.

Fire and Bilge Pumps.—In each fire room there is a 12-inch by 10-inch by 18-inch vertical, double-acting, single, fire and bilge pump, arranged to draw water from the bilge, the drainage system and the sea, and discharge to the fire main, the sanitary system and overboard.

Ash Hoists.—There are three ash hoist engines of the two-

cylinder, reversible type, one for each fire room, located in the upper hatch. The ventilators contain the bucket guides, ropes, sheaves, etc. The hoists are operated from the main deck. There are trolleys at this deck for delivering the ash buckets to the chutes at the ship's side.

Ash Expellers.—In addition to the ash hoists, three Stone pneumatic ash expellers are fitted, one in each fire room, discharging the ashes through the vessel's bottom.

Piping System

Main Steam.—The main steam piping is arranged in two symmetrical systems, one on each side of the vessel. The two lines are cross-connected in the forward fire room and in the engine room. The branches from the boilers are 5½ inches diameter each and the lines proper are 7½ inches in the forward fire room, increasing to 9½, 11, 12½ and 14 inches, at each successive boiler connection, the latter size being continued to the turbine regulating valves in the engine rooms.

Auxiliary Steam and Exhaust.—Auxiliary steam and exhaust lines are provided in the machinery space and elsewhere, as required for the various auxiliaries. These systems involve no special features worthy of notice.

Feed and Other Water Piping.—The main and auxiliary feed system, fire and bilge and drainage systems, etc., are installed according to the customary practice, a description of which is quite unnecessary.

Interior Communication

The customary engine and fire room telegraphs, gongs, time fire device, telephones, voice tubes, etc., are fitted for transmitting orders and signalling to the various machinery compartments and other parts of the vessel.

Air Compressor Plant

Located in the engine room are nine 11-inch by 11-inch by 12-inch Westinghouse steam driven air compressors, for use in running pneumatic tools in the engineering department, blowing soot off the boiler tubes and for the gas ejecting system for the guns. Each compressor has a capacity of about 360 cubic feet of free air per minute at 150 pounds pressure. A pneumatic main, independent of the gun gas ejecting system, is led throughout the machinery space, with branches to the workshop, evaporator and dynamo rooms, from which the connections for pneumatic tools are taken.

Evaporating and Distilling Plant

This plant is located on the berth deck, just forward of the engine hatches with the distillers in the port engine hatch at high elvation. There are four evaporators and four distillers with their accessories, arranged to operate in either single or double effect. The plant has a combined capacity of 25,000 gallons of water per 24 hours.

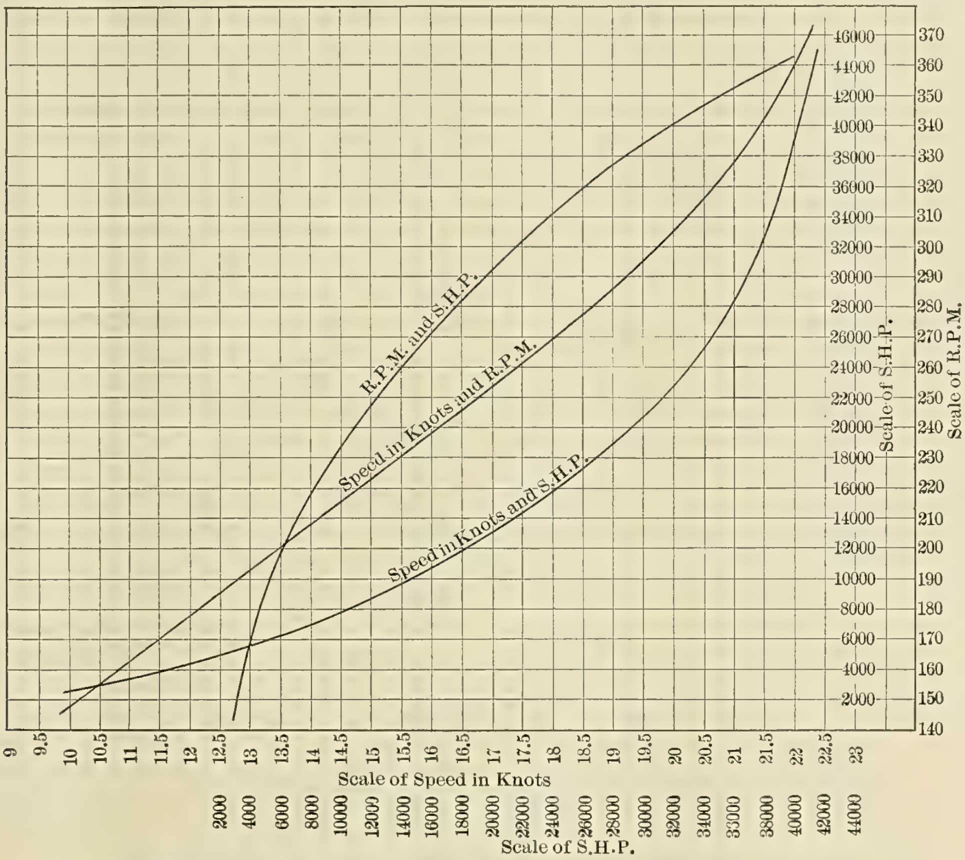


FIG. 4.—SPEED AND POWER CURVES FROM TRIALS OF UNITED STATES BATTLESHIP FLORIDA

Machine Shop

A well-equipped machine shop is located amidships, between the engine hatches, at the berth deck level. Each machine tool is driven by its own motor.

The following machine tools are installed:

One 24-inch by 48-inch extension-gap lathe.

One 12-inch tool-room lathe.

One 14-inch tool-room lathe.

One 15-inch by 15-inch column shaper.

One 30-inch plain radial drill.

One 16-inch sensitive drill.

One universal milling machine.

One double-emery grinder, wheel 12 inches diameter by 2-inch face.

One portable cylinder-boring machine.

The tools are all up to date and complete, and are provided with the most modern attachments.

There is also a well-equipped blacksmith shop, located on the main deck just abaft turret No. 3.

TABLE I.—STANDARDIZATION TRIAL DATA

Number of run	1	2	3	4	5	6	7	8	9	10
Direction of run	S.	N.	S.	N.	S.	N.	S.	N.	S.	N.
Time on course	4 m. 9.1 s.	5 m. 20.9 s.	4 m. 11.3 s.	6 m. 38.1 s.	5 m. 21.8 s.	7 m. 12.4 s.	3 m. 31.4 s.	4 m. 10.1 s.	3 m. 36 s.	3 m. 18.8 s.
Revolutions of main engines:										
To make one knot—mean of 4 shafts	798.23	996.57	802.23	994.58	787.08	1,020.68	823.95	958.63	849.65	936.75
Per minute ... Shaft No. 1	176.85	170.86	175.61	137.68	134.52	128.89	223.84	219.13	225.48	269.86
Shaft No. 2	213.37	207.10	212.01	165.41	161.20	156.05	268.49	266.04	271.09	324.88
Shaft No. 3	203.83	198.47	204.16	160.04	157.81	153.39	221.39	217.92	224.37	268.11
Shaft No. 4	175.16	169.14	174.36	136.40	133.55	128.50	221.46	217.42	223.51	268.30
Average per minute	192.30	186.39	191.54	149.88	146.77	141.71	233.80	230.13	236.11	282.79
Speed in knots	14.452	11.218	14.325	9.043	11.187	8.326	17.029	14.394	16.667	18.109
Horsepowers:										
S. H. P. ... Shaft No. 1	849	803	834	434	377	361	1,813	1,830	1,894	3,387
Shaft No. 2	2,240	2,133	2,163	1,125	999	983	4,457	4,549	4,609	8,187
Shaft No. 3	1,569	1,568	1,592	800	710	698	1,722	1,754	1,795	3,351
Shaft No. 4	788	744	767	396	374	347	1,750	1,739	1,810	3,354
Total S. H. P.	5,446	5,248	5,356	2,755	2,460	2,389	9,742	9,872	10,108	18,279
I. H. P. auxiliaries	670	670	652	685	637	603	755	746	723	872
Total S. H. P. and I. H. P.	6,116	5,918	6,008	3,440	3,097	2,992	10,497	10,618	10,831	19,151
Steam pressure:										
Gage ... Main steam ... P	210	210	203	215	215	208	210	220	212	205
Main steam ... S	205	207	200	210	210	205	203	214	205	193
Absolute ... At M.H.P. turbines ... P	17	15	18	11.5	10	10	37	35	37	65
At M.H.P. turbines ... S	20	20	20	15	14	14	43	40	45	70
At H. P. C. turbine	125	125	127	80	73	72	5	9	12	10.5
At I. C. P. turbine	50	55	58	35	31	30	115	110	116	188
At L. P. turbines ... P	2.5	2.5	2	1.5	1.5	1.5	5	5	5.5	6
At L. P. turbines ... S	9.5	9.5	9.5	9	8.75	8.75	10.5	10.25	10.5	12
Vacuum in inches ... P	29.1	29.2	29.2	29.3	29.3	29.3	28.8	29	28.9	28.7
Vacuum in inches ... S	29.1	29.1	29.1	29.1	29.2	29.2	29.1	29.2	29.2	28.9
Number of turbines in operation	6	6	6	6	6	6	5	5	5	5

Number of run	11	12	15	16	17	18	19	20	21	22
Direction of run	S.	N.	S.	N.	S.	N.	S.	N.	S.	N.
Time on course	3 m. 4.7 s.	3 m. 17.9 s.	2 m. 41.6 s.	2 m. 49.5 s	2 m. 39.7 s.	2 m. 45.9 s.	2 m. 40.8 s.	2 m. 57.8 s.	2 m. 49.7 s.	3 m. 0.7 s.
Revolutions of main engines:										
To make one knot—mean of 4 shafts	872.75	931.68	961.20	1,003.90	965.28	991.45	960.75	946.50	904.30	954.25
Per minute ... Shaft No. 1	271.02	270.15	358.43	357.75	363.29	358.92	361.74	318.83	320.25	317.34
Shaft No. 2	325.43	324.03	354.53	351.17	359.40	353.57	354.72	314.09	315.62	311.88
Shaft No. 3	269.49	267.44	357.29	355.82	364.04	360.54	358.10	321.87	323.71	321.34
Shaft No. 4	269.02	268.82	357.24	357.52	363.85	360.38	359.80	322.44	319.72	317.17
Average per minute	283.74	282.61	356.87	355.57	362.65	358.35	358.59	319.31	319.83	316.93
Speed in knots	19.491	18.191	22.277	21.239	22.542	21.700	22.388	20.247	21.214	19.923
Horsepowers:										
S. H. P. ... Shaft No. 1	3,388	3,390	9,054	9,087	9,504	9,282	9,532	5,994	6,155	6,080
Shaft No. 2	8,168	8,198	9,572	9,692	9,668	9,652	9,507	6,502	6,470	6,394
Shaft No. 3	3,379	3,338	8,128	9,678	10,219	10,023	9,590	7,172	6,974	6,963
Shaft No. 4	3,336	3,387	9,324	9,546	9,860	9,658	9,355	6,803	6,286	6,236
Total S. H. P.	18,271	18,313	36,078	38,003	39,251	38,615	37,984	26,471	25,885	25,673
I. H. P. auxiliaries	859	875	1,210	1,261	1,252	1,229	1,228	1,153	1,101	1,122
Total S. H. P. and I. H. P.	19,130	19,188	37,288	39,264	40,503	39,844	39,212	27,624	26,986	26,795
Steam pressure:										
Gage ... Main steam ... P	213	211	185	185	187	180	176	185	185	185
Main steam ... S	204	200	187	184	187	182	175	187	185	185
Absolute ... At M.H.P. turbines ... P	65	65	152	160	168	160	163	168	112	110
At M.H.P. turbines ... S	70	70	160	160	165	165	168	115	115	115
At H. P. C. turbine	8	7.5	12.5	8	8	10	10	10	8	8
At I. C. P. turbine	189	188	13.75	13.75	13.75	13.75	13.75	13.75	13.5	13.5
At L. P. turbines ... P	8.5	8.5	15	18	18.5	17	17.5	18	13.5	14.5
At L. P. turbines ... S	12	12	17	17	18	17.5	18	13.75	13.75	13.75
Vacuum in inches ... P	28.7	28.6	28	27.8	27.7	27.8	27.8	27.8	28.2	28.2
Vacuum in inches ... S	29	29	28.1	28.2	28.2	28.1	28	28.5	28.7	28.7
Number of turbines in operation	5	5	4	4	4	4	4	4	4	4

Electric Plant

There is one dynamo room located forward of the forward boiler room, and two distribution rooms, one forward and one aft, in which are located the lighting and power distribution boards for the respective parts of the ship. The forward distribution room also contains the generator boards.

The generator installation consists of four six-pole, compound-wound, 300-kilowatt General Electric generators, each driven by a two-stage horizontal Curtis turbine. Each generator will deliver at normal load 2,400 amperes of current at 125 volts when running at 1,500 revolutions per minute. The generators are capable of delivering ⅛-overload for two hours without injury.

There are two condensers of elliptical section for the exclusive use of the dynamo turbines. Each condenser has its independent air pump, centrifugal circulating pump and hot-well tank and pump. The exhaust piping is so arranged with cutout valves that either or both condensers can be used on any or all the generator sets.

The condensers are of the following principal dimensions:

Horizontal diameter inside shell, feet and inches	4-0
Vertical diameter inside shell, feet and inches	5-8¾
Thickness of shell, inches	¼
Length between tube sheets, feet and inches	6-8½
Thickness of tube sheets, inches	1
Number of tubes	2,190
Diameter of tubes, inches	⅝
Thickness of tubes, B.W.G.	16
Diameter exhaust nozzle, inches	28
Air-pump suction, inches	7
Circulating water inlet and outlet, inches	9
Cooling surface, square feet	2,403

TABLE II.—OFFICIAL TRIAL DATA

	4-Hour Full Power Trial.	24-Hour, 19-Knot Endurance Trial.		24-Hour 12-Knot Endurance Trial.
Speed in knots	22.08	19.19		12.08
Slip of propellers, percent of own speed, mean	27.67	20.98		19.32
Draft, mean on trial, feet and inches	27–10	27–9 41/64		27–6 21/64
Displacement, corresponding, tons	21,240	21,215		20,976
Number of turbines used	4	5 first 5 hours	4 last 19 hours	6
Number of boilers used	12	12		8
Grate surface used, square feet	1,428	1,428		952
Heating surface used, square feet	64,236	64,236		42,824
Pressures (average):				
Main steam—				
At boilers, pounds (gage)	210	202		203
Engine rooms, pounds (gage)	179.2	189.1		197.4
In steam belt—		5-turbine comb.	4-turbine comb.	
H. P. C. turbine, pounds (absolute)	10.8	9.3	9.2	114.4
I. P. C. turbine, pounds (absolute)	13.7	178	12.2	49.7
M. H. P. turbines, pounds (absolute)	173.1	73.6	87.6	17.2
L. P. turbines, pounds (absolute)	18.5	10	11.5	5
Barometer, inches of mercury	30.2	30.17	30.14	30.04
Vacuum in condensers, inches of mercury	28.4	28.9	28.5	29.6
Main feed line, at pumps, pounds (gage)	278	268.7		265.8
Auxiliary exhaust in feed heater, pounds (gage)	6.7	4.9		6.4
Forced lubrication system, pounds (gage)	13.3	12.6		11.1
Air pressure in fire rooms, inches of water	1.99	0.6		0
Temperatures, degrees F. (average):				
Main injection	39.8	52		45
Main overboard discharge	64.1	67.7		52.8
Feed water	197.8	201		223.3
Engine rooms, working platform	81.8	98.5		94.6
Fire rooms, working level	79	98		100
Outside air	31	53.2		53.4
Smoke pipes	620	536		381
Revolutions or double strokes per minute (average):				
Shaft No. 1	366.64	289.59		165.65
Shaft No. 2	361.24	293.68		195.45
Shaft No. 3	363.62	285.43		188.66
Shaft No. 4	364.11	289.32		164.29
Mean, all shafts	363.90	289.50		178.51
Main air pumps	23.5	18.8		17.3
Main circulating pumps	244.3	201.3		161.8
Main feed pumps	26.3	20.6		16.8
Forced draft blowers	712	573		Not used
Horsepower (average):				
Shaft No. 1, S. H. P.	10,039	4,488		646
Shaft No. 2, S. H. P.	10,370	5,281		1,583
Shaft No. 3, S. H. P.	10,148	4,710		1,415
Shaft No. 4, S. H. P.	9,954	4,880		789
Total S. H. P., all shafts	40,511	19,359		4,433
I. H. P. main air pumps	29	21		10
I. H. P. main circulating pumps	507	315		167
I. H. P. main feed pumps	129	99		41
I. H. P. chargeable to forced draft blowers	333	178		Not used
I. H. P. other auxiliaries	301	250		246
Total I. H. P., all auxiliaries	1,299	863		464
Total horsepower all machinery	41,810	20,222		4,897
Water consumption data:				
Pounds per hour—				
Main engines	493428	251,669		74,543
Auxiliaries	67,352	56,382		41,843
All machinery	560880	308,051		116386
Main engines, per S. H. P.	12.180	(a)13.000		16.815
Auxiliaries, per I. H. P.	51.849	65.333		90.179
All machinery, per total, H.P.	13.415	(b)15.233		23.767
All machinery, per S. H. P.	13.845	(c)15.913		26.254
Coal consumption data:				
Kind and quality	George's Creek, very good	Good		Good
B. T. U. per pound	No sample taken	No sample taken		No sample taken
Pounds per hour	66,586	34,720		10,920
Per S. H. P.	1.644	1.793		2.463
Per total H. P.	1.593	1.717		2.23
Per square foot of grate	46.629	24.314		11,471
Miscellaneous:				
S. H. P. per square foot of grate	28.369	13.557		4.657
Square foot of heating surface per S. H. P.	1.586	3.318		9.660
Square foot of cooling surface (main condensers) per S. H. P.	0.752	1.574		6.873
Pounds of water evaporated per pound of coal per hour	8.423	8.872		10.658
Knots per ton of coal	0.743	1.238		2.478

(a), (b) and (c) are averages for entire trial. For 5-turbine combination, first 5 hours of trial, (a) = 12.736, (b) = 14.995 and (c) = 15.668. For 4-turbine combination, last 19 hours of trial, (a) = 13.074, (b) = 15:301 and (c) = 15.982.

REFRIGERATING PLANT

There are four Allen dense air ice machines, each capable of producing the cooling effect of three tons of ice per day. One machine is located forward, primarily for cooling the forward magazines, but can be used on the cold-storage system if desired. The other machines are located aft the engine room hatches and are fitted for cold-storage service, ice making, etc., and for the midship and after magazines cooling systems. There are five refrigerating rooms, isolated by air locks and insulated with cork in the usual manner.

TORSION METERS

Each line of shafting is fitted with a Gary-Cummings torsion meter for ascertaining the shaft horsepower of the main turbines. This instrument, invented by Mr. H. R. Gary, late of the Bureau of Steam Engineering, U. S. N., and developed by Mr. H. H. Cummings, of the Cummings Ship Instrument Works of Boston, is designed to meet the specifications of the Navy Department, which require recording torsion meters. It is simple in construction, accurate in operation and gave satisfactory and consistent results on the trials.

In brief, the instrument as installed consists of a steel tube about fourteen feet long, placed within the axial hole of a section of line shaft in each line of shafting. One end of this tube is securely fastened to the shaft and the other end is supported near the shaft coupling by a ball bearing, hence being free to turn with reference to the shaft as the shaft twists under load. To this end of the tube is secured an arm at right angles to it, and extending radially through a slot out in the face of the coupling disk to the periphery. On the outer end of this arm and external to the shaft is attached a mechanism that actuates two marking points. It is evident that any twist in the shaft, as it rotates under load, will produce a slight turning movement between the shaft and the free end of the tube. This movement is transmitted through the arm to the marking points, which trace two short parallel lines on a card, the card being held in a frame supported independent of the shaft, that is brought into contact with the points only when it is desired to measure the torque of the shaft. The distance between the lines thus marked on the card, measured to proper scale, is a factor of the amount of torque developed in the shaft, from which the shaft horsepower is readily figured.

TRIALS

Four trials were required of the *Florida* as follows:

1. A progressive trial over a measured mile water course for standardizing the screws, extending from maximum down to about ten knots speed.

This trial, generally called the standarization trial, was run on the Rockland course Monday, March 25, 1912. The weather was clear with a brisk wind blowing almost parallel to the course. The first run was commenced about 6:30 A. M. in a southerly direction, the runs being alternately south and north. In all twenty-two runs were made over the measured mile at various speeds, but the data from only twenty runs was used in compiling the speed and power curves, runs Nos. 13 and 14 not being up to the speed desired, were thrown out. At the conclusion of the trial the *Florida* returned to anchor off the Rockland breakwater to prepare for the full power trial next day.

From the data obtained it was found to require 321.4 revolutions per minute of the main engines to attain the designed speed of 20.75 knots, 286.3 revolutions for 19 knots and 177.2 revolutions for 12 knots. Table 1 contains the data obtained on the various runs, from which the curves, Fig. 4, were plotted.

2. A full-speed trial of four hours' duration in the open sea at the highest speed obtainable, with an average air pressure in the ash pits not exceeding 2 inches of water and not over 185 pounds steam pressure at the main high-pressure turbines. The average speed to be at least 20.75 knots and the water consumption guarantee being 15 pounds per hour for

main engines and auxiliaries per shaft-horsepower of the main turbines.

This trial took place at sea off Rockland, Me., on Tuesday afternoon, March 26, 1912. The weather was clear, with gentle breezes and smooth sea. The designed speed was easily exceeded, an average speed of 22.08 knots being attained, which set a new record in the navy for battleships, and the guaranteed water rate was likewise bettered. Table II. gives a comparative list of the data obtained on this and the following trials.

3. An endurance and water and coal consumption trial in the open sea of twenty-four hours' duration at as nearly a uniform speed of 19 knots as possible. The average not to fall below that figure. The water consumption guarantee was 16.25 pounds on the same basis as the preceding trial.

The trial was started at 1:20 A. M., March 27, 1912, and terminated at the same hour on the following day. The weather was clear with light airs and a smooth sea. Unfortunately, unsatisfactory dummy clearances developed in the starboard low-pressure turbine, which rendered it necessary to disconnect the intermediate-pressure cruising turbine after five hours' running, and to proceed with the trial on the four-turbine combination, but in spite of this handicap the water consumption was within the guarantee. For data see Table II.

4. An endurance and water and coal consumption trial at 12 knots, under similar conditions to the preceding trial, the water consumption guarantee being 26 pounds on the same basis as before.

At 4:20 A. M., March 28, 1912, the trial commenced. The weather was excellent throughout the trial, there being no wind and a smooth sea. The water consumption on this trial was a little in excess of the guarantee, due to the high consumption of the auxiliaries. The data obtained on this trial is also given in Table II.

The conduct and result of all the trials was most satisfactory, and reflects much credit not only on the navy yard force, where the vessel was constructed, but particularly the ship's engineering force, to whose organization, skill and energy, displayed in handling the machinery throughout the trials, the success was largely due.

Foundering of the Titanic

While traveling at full speed on her maiden trip from Southampton to New York at 11:40 P. M. (ship's time), Sunday, April 14, the new White Star steamship *Titanic* of 45,000 gross tons collided with an iceberg at a point west longitude 50° 14', north latitude 41° 46', or about 1,150 miles east of New York. Less than three hours later the ship sank, carrying with her all on board except about 700 persons who were taken off in lifeboats and later picked up by the *Carpathia* of the Cunard Line. As the total number of persons on board the *Titanic* was 2,340, including officers and crew, the loss of life was about 1,600. The vessel was certified by the British Board of Trade to carry over 3,300 persons, but the certificate provided for only sufficient lifeboats to carry 950 persons.

Accurate information as to just what occurred on board the ship when she was struck and before she sank probably will never be known, for all the engineers and officers, except those whose duty it was to man the lifeboats, died bravely at their work. After sifting the great mass of contradictory and unwittingly distorted evidence offered by the survivors up to date, it seems that the ship was steaming at a speed of about 21 knots; the night was clear and no indications of ice had been detected, although warning of the presence of icebergs in that vicinity had been received by wireless. Just before the collision occurred an iceberg dead ahead was reported to the bridge from the crow's nest, and the course of the ship was changed to avoid a collision. The warning had come too late, however, and the vessel was struck by the submerged part of the iceberg on the starboard bow at about the position of the foremast. As only a slight jar was felt in the ship the blow was probably a glancing one, but as the helm had been thrown over and the stern swung to starboard, the momentum of the vessel probably caused the side of the ship to scrape along the submerged part of the iceberg, piercing her shell plating in several places from the second or third watertight bulkheads back into the boiler rooms, and thus flooding the forward holds. Some reports also indicate that the engine room began to fill.

A complete description of the *Titanic* and her sister ship the *Olympic* will be found in the December, 1910, June, 1911, and July, 1911, issues of International Marine Engineering. Further particulars of the general arrangement of the ship can be seen from the drawings which we reproduce herewith from *The Shipbuilder*.

Apparently the first compartment to be filled was that containing the mail room (shown on the orlop deck plan, Fig. 1); that is, the compartment between watertight bulkheads 3 and 4. Probably the compartment forward of that was also filled, and, as the stokers came on deck immediately after the collision, reporting that some of the boiler rooms were filling, it is evident that at least three of the watertight compartments began to fill at the start; and as this changed the trim of the vessel, partially submerging the bow, it is also probable that some of the other watertight bulkheads, through leakage and the excessive stresses occasioned by the flooding of the compartments, opened up and admitted water to other parts of the vessel until the forward part of the bulkhead deck was submerged, causing the ship to sink.

Whenever two adjacent compartments in the hull of a large passenger steamship like the *Titanic* are flooded the ship is in a dangerous condition, and if a third compartment should be filled the situation is critical. If the damage filled the ship is practically doomed to sink. If the damage due to a collision is confined to two compartments and the bulkheads hold and remain practically watertight, there will be sufficient reserve buoyancy to keep the ship afloat. Even a third compartment might be filled and still the ship would float, provided the flooded compartments were not adjacent.

The sub-division of the *Titanic* consists of: First, the cellular double bottom, which extends the full length of the ship from the stem to the stern. This is 5 feet 3 inches deep, and is increased to 6 feet 3 inches depth in the engine room. Besides the center keelson and a continuous longitudinal on each side 30 feet from the center line, there were five intercostal tank girders amidships on each side of the center keelson, and additional girders are fitted under the engine rooms.

From the double bottom to the upper deck, as shown in Fig. 1, the hull is divided transversely by fifteen transverse watertight bulkheads. Aft of the forward collision bulkhead there are three cargo holds, each 50 feet long. The bulkheads in the

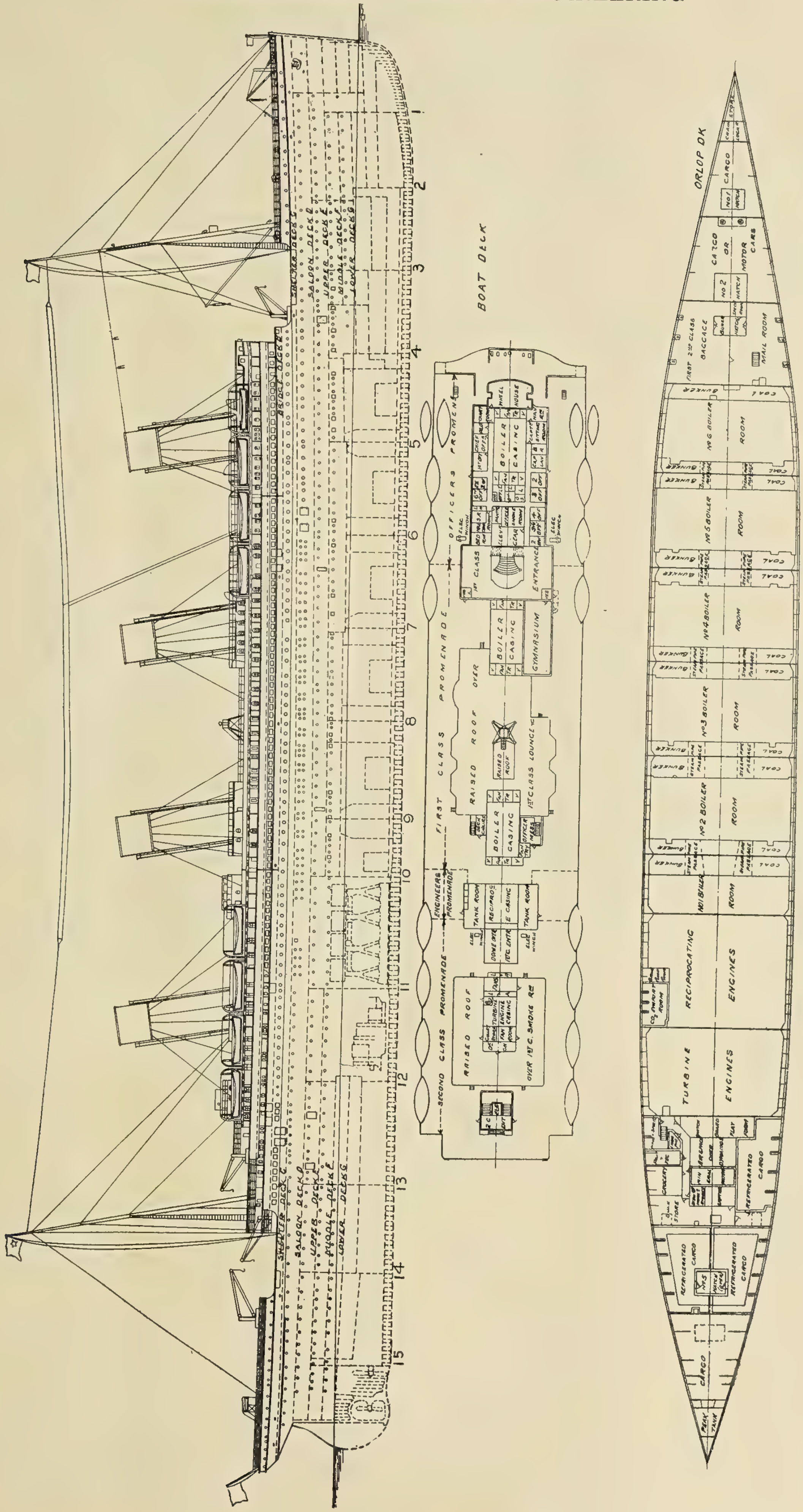


FIG. 1.—TITANIC, OUTBOARD PROFILE, BOAT DECK AND ORLOP DECK PLANS

holds are further reinforced by the steel decks, as shown in Fig. 1. Abaft the forward cargo holds are six boiler rooms, each of which, except the after one, which is nearest the engine room, is 57 feet long. The twenty-nine boilers are arranged side by side athwartships, five in each boiler room, as shown in Fig. 2.

The coal bunkers are arranged athwartships between the boiler rooms, and the watertight bulkheads which separate the

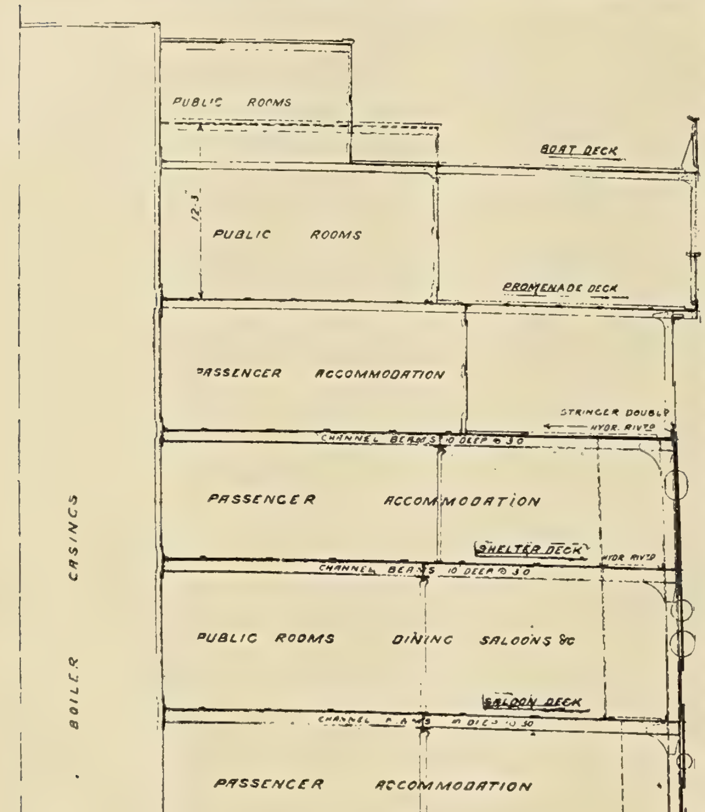


FIG. 2.—TITANIC, SECTION THROUGH BOILER ROOM

boiler rooms are located in the center of the bunkers, being stepped in way of the up-takes. Passageway is provided for between the boiler rooms through alleyways, where the watertight bulkheads are carried to the coal bunker bulkheads, and there are located the watertight doors, which can be automatically closed from the bridge.

Abaft the boiler space is the largest compartment in the ship, which is the reciprocating engine room, about 69 feet long. Abaft this is the turbine engine room, 54 feet long. Aft the machinery space are two other cargo holds. Most of the auxiliary machinery, including condensers and pumps, is located in the main engine rooms, but in the compartment aft the turbine room are the principal electric generating sets. There are also two 30-kilowatt auxiliary sets, situated on a platform in the engine casing at the saloon deck level, well above the waterline, so that in the event of flooding the main electric plant, lighting and power could be obtained from the auxiliary plant, a circumstance which probably accounts for the fact that the ship was kept lighted until she sank.

The sub-division of the part of the ship forward of the boiler space, where it is expected that most of the damage from a collision would occur, is reinforced in addition to the ordinary frames and bulkheads by longitudinal girders at each deck level; the transverse deck beams, which are of channel section 10 inches deep, are placed according to the spacing of the frames and secured thereto by efficient brackets. At the deck levels there are four longitudinal girders which extend the whole length of the ship, except in the machinery space, where special girders are provided of a sectional area equivalent to the four girders in the other parts of the ship. These girders are suitably supported by stanchions and columns. Thus these longitudinal girders, besides supporting the decks, furnished support against deflection of the transverse watertight bulkheads which separate the compartments.

The fifteen transverse watertight bulkheads extend from the double bottom to the upper deck at the forward end of the ship, and from the double bottom to the saloon deck at the after end of the ship, so that all the bulkheads extend far above the load waterline and give a considerable margin for the emersion of the ship by the flooding of a limited number of the compartments. It is evident, therefore, that the hull structure of the *Titanic* was of exceptional strength.

Without further information, however, regarding the scantlings of the hull and without definite information concerning just which compartments were filled directly by the piercing of the skin of the ship, or by leakage through the transverse bulkheads, and with no knowledge of the rate at which the compartments were filled or the effectiveness of the pumps and the bulkhead deck, no accurate assumption can be made as to the longitudinal bending stresses or the shearing stresses at any section of the hull. The first reports from the survivors even indicated that there was a breakage or partial rupture, or bending of the hull, at a point aft of the 'midship section. Such an occurrence has taken place on at least three steel ships which foundered, but in those cases the ratios of breadth and depth to length were abnormal. In modern ship design the maximum shearing and longitudinal stresses are proportioned for cases as extreme, if not more extreme, than that in which the *Titanic* was placed, although the *Titanic* was in about the worst condition as far as the stresses are concerned that a ship can be placed.

The effectiveness of the watertight bulkheads is also doubtful. Their absolute tightness might very well be questioned, but from the nature of the design of the *Titanic*, unless the load due to the water pressure in the flooded compartments was augmented by the weight of the contents of the holds brought upon the bulkheads by the inclination of the ship just before she finally sank, there is every reason to suppose that they held and maintained the structure intact.

A matter of vital importance in a disaster like this is the equipment of life-saving apparatus. Inadequate as it was on the *Titanic* it is gratifying to find that, in spite of the fact that the lifeboats were partly in charge of inexperienced men, yet it was possible to launch all safely regardless of the inclination of the vessel.

Old American Coasting and Sound Steamers—Part II

BY FRANCIS B. C. BRADLEE

The first steamboat worthy of the name to ply on the coast of Maine was the *Patent*. She is described as follows by the Portland *Argus* of July 8, 1824:

"The steamboat *Patent*, Capt. Seward Porter, arrived here yesterday, in four days from New York, having touched at a number of places to land passengers. Her engine has been proved to be of superior workmanship and propels the boat about 10 miles an hour."

In a report made to the stockholders she is described as of 200 tons and as costing $20,000 (£4,110). She had one mast and a staff at her stern, from which was displayed the Stars and Stripes. The *Patent* was low and without a hurricane deck; her boiler and engine were below, and she had a heavy balance wheel half above the deck, and an arrangement by which the paddle-wheels could be disconnected. Her cabins were all below. The quarter deck was clear, with seats all round it. In the Boston *Courier* of Aug. 12, 1824, her arrival from Portland on the 8th is noticed, stating that she brought seventeen passengers and made the trip in 17½ hours against a head wind (distance 110 miles).

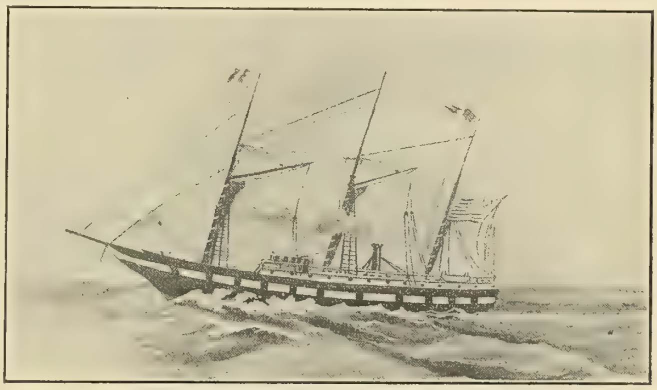
Several small steamboats followed the advent of the *Patent*, and by 1826 what was known as a "steam brig," called the

STEAM BRIG NEW YORK, BUILT IN 1822. ONE OF THE EARLIEST SEA-GOING STEAMERS IN THE UNITED STATES
(From a negative in the author's collection)

New York, built in New York in 1822, was running on the coast. She was owned by a Mr. Bartlett, of Eastport, Me., who fitted her with new machinery and ran her regularly between Boston, Portland, Eastport and other ports on the coast. In 1829 the *New York*, while on her way to Eastport, caught fire when about 8 miles to the eastward of Petit Menan Light, and burned to the water's edge. Luckily there was no loss of life. One reason for the fire spreading so rapidly was "that no fire engine, hose or buckets could be found on board." This throws light on the way some of the early steamboats were managed. The *New York* had full, round lines, flush deck, long scroll head, like the packet ships of that day, her name painted on the paddle boxes, with the addition New York and Norfolk packet. In 1832 the *Chancellor Livingston*, that had for years run on the Hudson River and Long Island Sound, was sold to Cornelius Vanderbilt, who placed her on the Boston-Portland route. She was 496 tons, 157 feet long, 33 feet beam, 10 feet depth, with a "cross-head" engine having a 56-inch cylinder with 6-foot stroke. The *Chancellor Livingston* was considered much superior to any of the other Maine coast steamboats of that time, and was in use until 1834, when, showing signs of wear, a new steamer called the *Portland* (163 feet by 27 feet by 11 feet) was built to take her place, the engine from the *Livingston* being transferred to her. The *Portland* was very successful, being in use as late as 1850.

During this early period there were many steamers on the Maine coast that ran there for short periods only, being sold or transferred to other routes, and these not coming within the scope of this article we shall not mention them. In 1833 the Boston & Bangor Steamship Company started with a wooden side-wheel boat called the *Bangor*, built in New York by Brown & Bell. She was about 160 feet long, and had a "cross-head" engine with a cylinder 36 inches in diameter, 9 feet stroke. This vessel was sold to the Turkish Government in 1842, and sent across the Atlantic to Constantinople. (See the article on Old American Transatlantic Steam Liners.)

In 1845 the Bangor Steamship Company brought forward a most curious and famous steamer. She was also called the *Bangor*, and is memorable as being the first iron and screw propelled seagoing craft in the United States. The hull and



COAST OF MAINE SCREW STEAMER BANGOR OF 1845
(From a painting in the author's possession)

machinery (begun in 1843 and not finished until 1845) were constructed by Betts, Harlan & Hollingsworth, at Wilmington, Del., the tonnage of the *Bangor* being 231; length, 120 feet; breadth, 23 feet; depth of hold, 9 feet. The engines were what was known as the "Loper" type, consisting of two independent cylinders, each 22 inches in diameter by 24 inches stroke of piston; the boiler was of iron, of the drop-flue type, 20 feet in length, and there were twin-screw propellers, each 8½ feet in diameter. The *Bangor* made 15.7 statute miles on her trial trip, but on Aug. 31, 1845, soon after beginning her regular trips, she was burned off the Maine coast, but was rebuilt, and again placed on the Boston and Bangor route. In December, 1846, she was purchased by the United States Government, renamed the *Scourge*, and used as man-of-war during the Mexican War. She was afterwards sold to persons in Louisiana.

In the 50's the best-known Bangor boats were the *Penobscot* and *Boston*, belonging to Sanford's Independent Line, and the *Daniel Webster*, owned by the Boston & Bangor Steamship Company. These boats varied in length from 220 to 240 feet, and had beam engines with cylinders 48 to 52 inches in diameter by 11 feet stroke. The *Daniel Webster* was considered the finest of these three steamers, and ran mostly

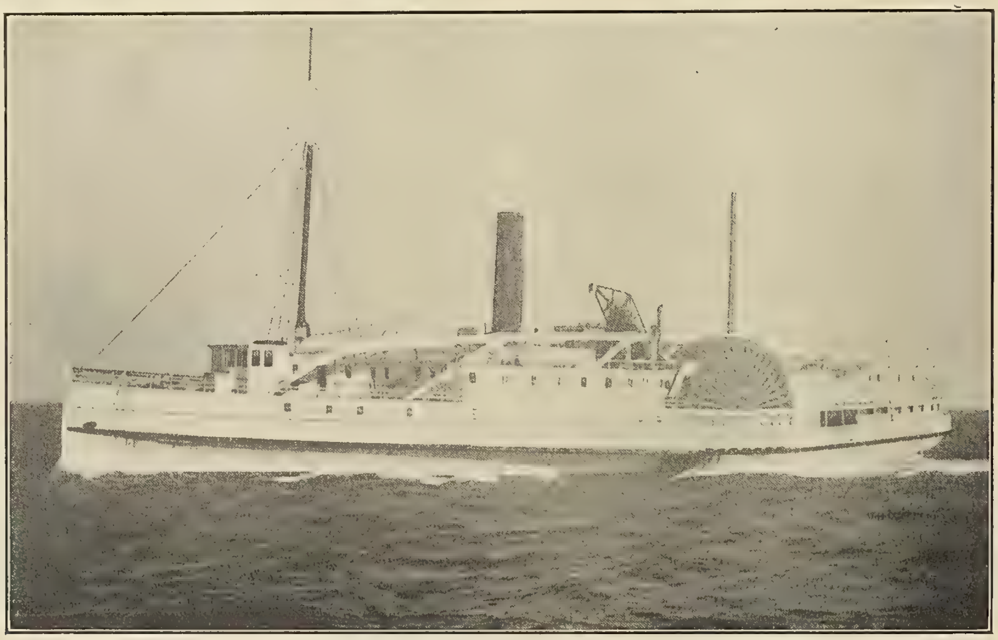
between Portland and Bangor in connection with what was known as the "steamboat train" to and from Boston on the Eastern Railroad.

In 1863 the Bangor Line had constructed by John Englis & Son, New York, the *Katahdin,* 1,234 tons gross, 241 feet by 34 feet by 12 feet, with a beam engine having a 50-inch cylinder by 11 feet stroke; and in 1867 the same builders constructed the *Cambridge,* 1,327 tons gross, 250 feet long, 38 feet beam, 13 feet depth of hold, with a beam engine having one cylinder 60 inches in diameter by 11 feet stroke. The latter vessel ran ashore on Georges Island, coast of Maine, Feb. 10, 1886, and became a total loss, and the *Katahdin* was broken up for old junk about 1895.

In 1843 the various steamers running to Portland were consolidated into one concern known as the Portland Steam Packet Company. Their first steamers were two wooden propellers, the *Commodore Preble* and the *General Warren,* each boat being 150 feet long, 24 feet beam, 8 feet depth of hold, and having high-pressure engines with two cylinders each 18 inches in diameter by 24 inches stroke. At the time of the discovery of gold in California in 1849 these two steamers were sold for service on that coast, and sent round via Cape Horn, being nine months on the voyage.

For some reason or other, probably because of their small passenger accommodation, propellers were not popular at first on the coastwise route, so the Portland Line soon replaced the *Commodore Preble* and *General Warren* by side-wheel boats named the *Atlantic* and *St. Lawrence.* These were followed by the *Forest City* in 1854, the *Lewiston* in 1856, and the *Montreal* in 1857, wooden side-wheelers, about 235 feet long and 33 feet beam, with beam engines having 52-inch cylinders by 11 feet stroke. The *Lewiston* was afterwards sold to the Portland, Bar Harbor & Machias Steamboat Company, and in 1867 the *John Brooks* was bought, a wooden side-wheeler, 250 feet long, 34 feet beam, with the usual beam engine; she had previously run on Long Island Sound. After her followed the *Tremont* (1883), and the ill-fated *Portland* in 1890, still wooden paddle-wheel steamers, and it was not until 1900 that the Portland Steam Packet Company had a modern steel propeller steamer built, which was called the *Governor Dingley.*

(*To be concluded*)



COAST OF MAINE STEAMBOAT FOREST CITY, 1854
(Negative from N. L. Stebbins)

Launching of the U. S. Destroyer Henley

The torpedo boat destroyer *Henley* was launched at the works of the Fore River Shipbuilding Company, Quincy, Mass., April 3. The principal dimensions of the vessel are as follows:

Length between perpendiculars.....	289 feet.
Length over all.....................	293 feet 10½ inches.
Breadth, molded	26 feet 4½ inches.
Trial displacement	742 tons.
Trial draft	8 feet 4 inches.

Battery—Five 3-inch guns, three 45 c/m torpedo tubes on deck, two .30-caliber automatic guns.

The contract was signed on Nov. 28, 1910, and calls for delivery on Nov. 28, 1912.

The machinery spaces occupy the 'amidship portion of the destroyer, the installation consisting of four Fore River-Yarrow watertube boilers. The vessel is fitted with two 18-stage Curtis reversible marine turbines, 63 inches in diameter, and capable of developing 5,500 shaft-horsepower each at about 585 revolutions per minute, which will give the vessel a speed of 29½ knots.

For the purpose of bettering the economy of consumption of steam at low speeds there has been fitted at the forward end of each turbine, and connected to it by means of a jaw clutch, a 10½-inch by 22-inch by 10-inch stroke-vertical, compound reciprocating engine, which at 16 knots is intended to develop 400 indicated horsepower at 280 revolutions per minute, with a steam pressure of 250 pounds in the high-pressure chest. The steam, after passing through this engine, is put through the turbine, and the energy remaining in the steam after passing through the reciprocating engine is extracted down to the last ounce of pressure in the turbine. Shop tests of this unit, conducted by a naval board last December, showed, according to the report of the board, that the gain in economy at 16 knots amounted to 33 percent, at 13 knots 62.4 percent, and at 10 knots 98.96 percent over the performance of the turbine under similar conditions of steam. The contractors guaranteed that the gain at 16 knots would be 25 percent. It is expected that the *Henley* will be the most economical torpedo boat destroyer in the United States navy at all speeds from 10 knots up to 31.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Efficiency of Turbines at Cruising Speeds

The 400-horsepower reciprocating engines which are to be installed forward of the 5,500 shaft-horsepower turbines (Curtis) of the United States destroyer *Henley* will probably give the desired economy at cruising speed, but in the case of similar installations in battlships the increased length of engine rooms would be a disadvantage and the engine would be large on account of the necessarily small piston speed.

To take a concrete case, consider the battleship *North Dakota.* She is a twin-screw vessel with Curtis turbines. At a speed of 21.6 knots the shaft-horsepower was 15,900 on each shaft, and the revolutions 280, while at a cruising speed of, say, 12 knots, the shaft-horsepower was 1,911 and the revolutions 143; that is, the revolutions were reduced to one-half and the horsepower to one-eighth. The steam consumption was 13 pounds per horsepower per hour in the first case, and 20 pounds per horsepower per hour in the second. Nineteen nozzles were used in the first case and four in the second.

If a clutch was put in the shafting abaft the turbine for direct drive at full power, it could be thrown out and a one to two reduction gear used for the lower speed, which, as it needs only 1,911 horsepower, would not require very heavy gearing. A greater ratio might be used so that the turbine could run above the normal speed and increase the efficiency. The clutch and gearing could be fitted in the shaft alleys, which are of little value except as space for engineers' stores.

Another installation which would make no change in the main shafting, except to add one gear to it, would be the addition of small high-speed turbine or reciprocating engine geared to the main shaft, the exhaust from same discharging into the main turbine. As the safety of the vessel would not be dependent on this auxiliary machinery, it could approach torpedo-boat design in speed and weight. Of course, in the case of the turbine the speed reduction could be very considerable and the turbine very small.

The Government is now making radical experiments in methods of power transmission on the colliers, but all for full power. Would it not be advisable to try the merits of the above propositions on similar war vessels? Any one of the installations would weigh less and take less room than the *Henley* type; in fact, none of them would increase the engine weights by more than 3 to 6 percent.

Brooklyn, N. Y. R. E. Barry, A. I. N. A.

Explosion of an Intermediate Stop-Valve Chest

The steamship *T*——— was on a voyage from Bristol, in England, to Galveston, Texas. Everything during the voyage across had worked well, and when the explosion I am going to speak of happened the voyage was nearly at an end.

The stop valve I write of was an ordinary brass valve 10 inches in diameter. It worked by a rod and wheel from the starting platform. A brass nut was fitted in the saddle of the cover to take the spindle, which had a square thread ¼-inch pitch. The diameter of the cover was 18 inches, and the mean thickness was 1 inch.

No repairs had been required previous to this explosion. The machinery, etc., had all been inspected and passed by the superintending engineer.

We had come to anchor waiting for the weather to calm down so that we might get a pilot, and it was during this time that, without any warning, the cover of the intermediate stop valve blew off. Three of the studs were also broken off.

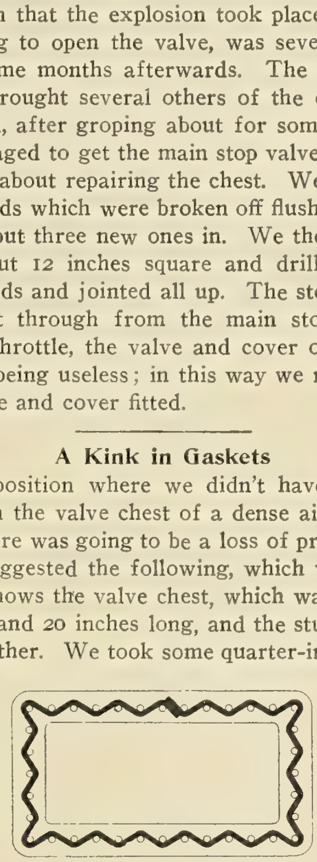
One of the engineers had opened the stop valves on the boilers, eased the throttle, and had also opened all the drain cocks; he then proceeded to open the intermediate stop valve and it was then that the explosion took place. The engineer, who was trying to open the valve, was severely scalded and laid up for some months afterwards. The noise of the escaping steam brought several others of the engineroom staff to the spot and, after groping about for some minutes in the steam, we managed to get the main stop valves shut.

We then set about repairing the chest. We had to drill out three 1-inch studs which were broken off flush with the face of the chest, and put three new ones in. We then got a piece of steel plate about 12 inches square and drilled holes to suit the pitch of studs and jointed all up. The steam was allowed to run straight through from the main stop valves of the boilers to the throttle, the valve and cover of the intermediate stop valve being useless; in this way we reached port and had a new valve and cover fitted. F. J. S. N.

A Kink in Gaskets

Being in a position where we didn't have any gasket to make a joint in the valve chest of a dense air ice machine, it looked as if there was going to be a loss of provisions, but one of the oilers suggested the following, which was carried out:

The sketch shows the valve chest, which was approximately 14 inches wide and 20 inches long, and the studs were moderately close together. We took some quarter-inch square pack-



GASKET FOR A VALVE CHEST

ing and laced it round the studs, as sketched, and put on the cover and drew it down. This gasket lasted longer than any we had ever had, and since then I have given up cutting out flat gaskets and saved considerable time for ourselves and money for the owners. Usually common sense metallic packing is used in these ice machines; but they are quite a little trouble to handle, and I think that what is here suggested can be used not only in such a place but in many others advantageously. Tramp Steamer.

Fitting a Tail Shaft Ring

Fitting a brass retaining ring on the tail shaft of the German steamer *Itauri,* without docking the vessel and while cargo was being handled, was the unusual feat recently performed in Seattle harbor by the Heffernan Engine Works. During her long passage from Europe, stopping en route at many ports along the west coast of South America, the *Itauri* was subjected to severe service, and when she reached this port it was found that the retaining ring was so badly worn as to require replacing. The engineering staff aboard stated

it was impossible to make the repairs without docking the vessel. As it was imperative that she discharge and be dispatched as quickly as possible, docking was the last resort. When the *Itauri* arrived she was drawing 13 feet aft. To put her down by the head as much as possible, 350 tons of iron were discharged from the afterhold, No. 1 hold was filled with 1,000 tons of flour, while No. 1 tank was filled and the after tanks were pumped out. This put the vessel down by the head by about ten feet, bringing the propeller high out of water. The shaft at the retaining ring was then partially under the surface.

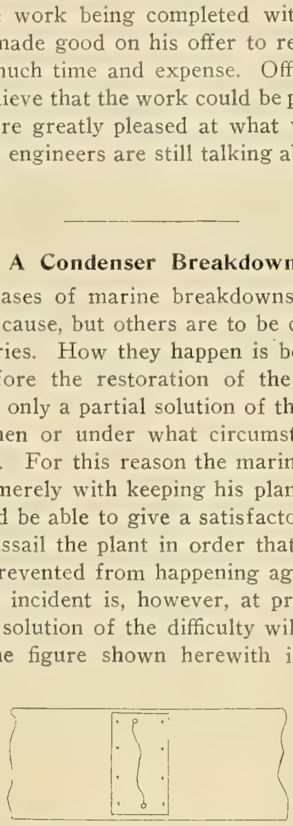
The brass ring was made in two pieces, dovetailing into each other, one section going under the shaft and the other on top. With the assistance of a diver the two parts of the ring were placed around the shaft, bolted together and screwed on, the work being completed within a few hours. Mr. Heffernan made good on his offer to repair under water, thereby saving much time and expense. Officers of the vessel would hardly believe that the work could be performed without docking, and were greatly pleased at what was accomplished, and local marine engineers are still talking about the feat.

Seattle, Wash. R. C. Hill.

A Condenser Breakdown

Most of the cases of marine breakdowns can be traced to some assignable cause, but others are to be classed purely and simply as mysteries. How they happen is beyond comprehension, and therefore the restoration of the plant to normal working order is only a partial solution of the difficulty, as one never knows when or under what circumstances the trouble may occur again. For this reason the marine engineer should not be satisfied merely with keeping his plant in running condition; he should be able to give a satisfactory reason for the troubles which assail the plant in order that they may, as far as possible, be prevented from happening again.

The following incident is, however, at present without explanation, and a solution of the difficulty will be welcomed by the writer: The figure shown herewith is a view looking



CRACK ON A CONDENSER

down upon the top of a condenser of the usual surface type found on board ship, showing a rather extensive crack which developed between two columns. How the fracture occurred no one knows, the only thing definitely known about it being that the condenser was found cracked, as shown, when the vessel was about seven days out of port. The way the trouble was discovered was by the condenser losing its vacuum, and as this happened very rapidly the inference is that the formation of the crack and the losing of the vacuum occurred practically at the same instant. The reason for the crack could, however, not be found. It might have been understood quite well if the engines had been warmed up quickly, leaving the condenser cold; but this was not the case, so the incident must rank as one of the mysteries which so often occur at sea.

The sketch also illustrates how the damage was repaired, although there is nothing extraordinary about that part of the subject. At each end of the crack a hole was drilled in the condenser and plugged in order to prevent the crack from extending. Then a piece of plate ⅝ inch thick was cut to amply cover the crack and secured to the condenser surface by means of ⅝-inch bolts, a sheet of jointing material being placed between the plate and the condenser surface to keep the vacuum.

The Pump Trouble

It was some time ago, I admit, that the late chief engineer of the good ship *Sun* found himself a stoker on the tramp steamer *Anna*, not *Ann*. It wouldn't have been wise to put any question as to the age of this vessel within the hearing of the captain. Yes, I was stoking with a first-class certificate in my clothes, but I regret to say that my earthly possessions consisted of what I had on, and that certificate; and my main wish was for cooling drinks and to get away from shore. Yes, it was "booze" that did it, but that was long ago and another story.

I was picked up by the chief engineer of the *Anna* for no other reason that I know of except that I was white and spoke English. He was a down-East Yankee, weighing about 110 pounds, and I am sorry to say that his clothes and traps bore the name of "Lomedieu," yet the certificate of the chief engineer of the *Anna* was not spelled that way, but "McPherson." At that time in my life I did not care much about such matters.

After twenty-one days I got "noticed," and think the chief had been prowling around my clothes when I was asleep and saw the certificate. At any rate, I was taken into the engine room. Two days later, I was told to overlook a boiler feed-pump which had suddenly given out, or rather, instead of working its usual twenty or so strokes a minute, it took to making two or three hundred or more, and while it pumped some water it didn't pump much. I took off the water end of the cylinder head and steam end, as I supposed that the water piston rings were broken or the soft packing given out, and took out the piston rod. Right here let me say that the *Anna* had its work done cheap when repairs were concerned, and the piston rod was a sample of the style of work demanded, and obtained and accepted, being a piece of cold-rolled shafting with the water piston riveted on one end and a die-cut thread and shoulder on the steam end. I found both ends O.K. and nothing seemed to be the matter. I reported to the chief, who took a look, and told me to close her up again and use the old gasket. We did not use the pump for several days, and only started it up, when we got into port, to wash boilers; then it seemed to work all right for a day of two.

By that time I was feeling all right, and the chief told me that I should get no more money, but I was to be his "First," and I was to attend to my duties and keep my mouth shut and my eyes open. We started out a day or two afterwards, and after a few hours I started up the pump. It worked all right for a few minutes and then it began to fly away, and we had our troubles with it; but it kept on feeding sufficient for the purpose.

The chief made some uncomplimentary remarks about me, and then had the pump taken apart himself, but could find nothing; but, being called away before it was put together, I had a chance to look it over, and here was the trouble.

On account of the cheap job no shoulder had been turned on the water end of the piston-rod, but it had just been shoved in "any old way" and riveted over. After a while this worked loose and the piston-rod would keep on working through the piston, sometimes carrying it along with it and sometimes not. I took a great deal of pleasure in calling the attention of the chief to the fact that it paid to do a job well. He remarked this was true when you didn't have to pay for it yourself,, but he had noticed that engineers who had no interest in the ship had a change of heart when they got an interest in it as regards repairs. Anti-Booze.

Work on the Argentine battleship *Rivadavia* at the yards of the Fore River Shipbuilding Company, Quincy, Mass., has progressed to the stage where the turbine rotors are being placed on board. Much of the auxiliary machinery is already in position, the boilers are complete and the condensers are ready to be installed as soon as the turbines are in position.

Review of Important Marine Articles in the Engineering Press

A Comparison of the Cost of Dreadnoughts in England, Germany, France, Austria and the United States.—Translated from an article of Naval Constructor Louis Barberis, R. I. N., in Rivista Marittima, by A. Conti. Attention of the reader is called to different methods of accounting used in the countries compared. After correcting for these differences, according to the best knowledge obtainable, costs per ton and for the completed ships are given. The most valuable part of the paper consists of tables of costs of dreadnoughts of all the Powers sub-divided into the general items of expense going to make up the completed ship. 6,200 words.—*Journal of the American Society of Naval Engineers,* February.

A Further Note on Approximate Stability.—By Arthur R. Liddell, Charlottenburg. General rules have not yet been laid down for the determination of a suitable metacentric height for vessels of different sizes and types nor have the principles that underlie its variations been made clear. In this article a suggestion is made with this as its purpose. To make the consideration general, the stability conditions of rectangular blocks of different proportions of depth to breadth are dealt with. If curves of levers be laid off for such a block, or series of blocks, with molded depth to breadth ratio ranging from .4 to .6, it will be seen that with a given height of metacenter the range of stability varies considerably. If, however, a particular range of stability be laid down the metacentric height corresponding will vary so that it is too large in some of the blocks and too small in others. To lay down distinct limits for either is impossible, and a compromise must be made in some way. The suggestion of the author is to establish a certain fraction of the breadth as a desirable metacenter for a block with molded depth equal to one half breadth, and for all other proportions of block to halve the difference between this height and the metacentric height that would give the same range as the standard proportion. The ranges of positive stability thus arising will have values that are approximately means between the two cases given above. The remainder of the article consists of examples of the use of this suggestion, and in showing how impossible it is to find a method for accurate use that covers all cases. 2,700 words.—*The Engineer,* February 23.

The Davis Gun-Torpedo.—The essential features of this invention is the substitution of a gun firing a shell for the explosive head of a torpedo. By the use of vanadium steel of very high elastic limit an 8-inch gun and shell is mounted in the warhead of a torpedo with an actual saving in weight over the usual charge of gun cotton carried in the largest size of explosive head. The object is to preject the shell of this submarine gun through all torpedo nets and armor within the vitals of the ship itself where the charge of the shell is exploded by means of a time fuse. Tests have been carried out in the waters of Chesapeake Bay by the inventor, Commander Cleland Davis, U. S. N., and more recently by the United States Government. These have shown that great destruction results from the use of the weapon, and all claims for it have been substantiated. Some difficulty has been experienced in making the fuse act at precisely the right time, but otherwise the penetrative possibilities of the attack have been fully realized. Illustrated with photographs and diagrams. 1,900 words.—*The Engineer,* February 23.

Floating Dock for Testing Submarines.—A floating dock of novel construction has recently been built by the Fiat San Giorgio, Spezia, the chief object of which is to enable external pressure tests to be applied to hulls of submarines without having recourse to deep-sea diving tests. The main portion of the dock consists of a hollow tube, having one end permanently closed, the other fitted with a hollow circular door. Two centrifugal pumps enable the dock to be lowered to receive a submarine and rise with its load, while a third pump enables the pressure to be maintained within the dock for testing purposes. When floating light the displacement is said to be 500 tons, when loaded 925 tons, and when docking a vessel the draft is increased from 7 feet light and 10 feet loaded to 17 feet 9 inches. 550 words. Photographs and drawings.—*Engineering,* February 23.

Anti-Rolling Devices for Ships.—By E. C. Given, M. Inst. C. E., M. I. Mech. E., M. I. N. A. Read before the Liverpool Engineering Society. A well-written summary of the use of anti-rolling devices from their introduction to the present time, giving for each instance the name of steamer, her size, the general characteristics of the system used and its results. More is said concerning the recent developments by Dr. Frahm, of Blohm and Voss. A recent paper by the inventor has been reviewed in these columns. This system has been successfully tried on the Cunard Line steamship *Laconia,* and will be installed in the *Aquatania,* now building. A brief statement of the principle on which the device works may be said to be the use of a secondary and artificial resonance to damp the primary resonance between the waves and ship. A ship rolls in periods of her individual oscillation even if the impulse be more or less irregular. As the ship lags 90 degrees; that is to say, a quarter of her period behind the wave, so the phase of the tank water lags 90 degrees behind the ship; that is, 180 degrees behind the wave, and the result is that the water having been put in motion by one wave of a series damps the rolling tendency from the next. 4,000 words. —*The Steamship,* March.

Screw Propeller Design.—By Capt. C. W. Dyson. After the publication of the article with the above title in the August, 1911, number of the *Journal of the American Society of Naval Engineers,* the *London Engineer* called attention to the fact that it is not the block coefficient of the ship alone which should be used in determining its propeller. This point has been thoroughly understood by the author, but not until this contribution has he found suitable form for expressing this variable. By adopting the system of "Parent Lines" used by Naval Constructor Taylor in his book on "Speed and Power of Ships," a "Guide Chart for Correction of Block" has been produced, and is herewith submitted as the most practicable method of graphically illustrating the correction of block to be used in the selection of slip charts where any ordinary departure from the relative dimensions of the standard basic vessel occurs. Capt. Dyson then proceeds to explain the development of the corrective chart and gives it for use in design. 1,200 words.—*Journal of the American Society of Naval Engineers,* February.

The Possibilities of Flue Gas Economizers on Board Ship. —By Mr. R. Royds, M. Sc., and Mr. J. W. Campbell, M. Sc. Suggested by previous experiments for this form of heat saving on board ship and prompted by the recent adoption of feed-water heating on locomotives of the Egyptian State Railway, the authors have given extensive reports of experiments carried on at the Glasgow and West of Scotland Technical College. The purpose of these was to determine the effect of varying speeds of water and air through tubes on the transmission of heat from these mediums to the surrounding air. The report is mathematical in its nature, but gives also tabu-

lated data and a statement of practical results obtained. Useful results are claimed to have been obtained, although it is more of a store of experimental data than a statement of practical knowledge. Following the paper is a discussion by various members, both for and against the practical adoption of the apparatus suggested. 7,000 words.—*Transactions of the Institute of Engineers and Shipbuilders in Scotland;* Fifty-fifth Session, 1911-1912.

The Naval Reciprocating Steam Engine, its Characteristics, Dimensions and Economics.—By Ernest N. Janson. A careful review of reciprocating engine practice in the United States navy for the past twenty years in all principal considerations of design. The article refers especially to battleship engines, though allusions are made to engines of other types of craft. It gives tables of design, data and a chart showing the progress in engine performance during that time. It contains a drawing of the elevation of one of the engines of the battleship *Delaware.* On the whole, one of the clearest reviews of the subject we have seen for some time. 13,500 words.—*Journal of the American Society of Naval Engineers,* February.

Alternating Current on Shipboard.—By Lieut. A. Norris, U. S. N. A careful and complete statement of the case of the alternating current versus direct current on board warships in every practical detail. All electrical installations at present in use on shipboard are on the direct-current system. That the use of alternating current is practicable may be inferred from its use in the German navy and several foreign merchant fleets. The use of this system on shore is well known to have advantages not obtained by the use of direct-current systems. Some of these are: cheaper cost of installation, cheaper cost of production per kilowatt-hour, cheaper cost of mechanical and labor upkeep, less space and weight required for the plant, simpler construction and higher efficiency of machines, increased ease of voltage regulation. The scope of the paper is to outline a tentative design for use on a battleship under service conditions, and as the first step in accomplishing this the author lists all motors required for such a service. Next, he considers types and sizes of motors best filling these needs. The induction motor is the type depended on to give best results in this service and characteristic curves are given for suitable machines. All departments of the ship's electric installation are dealt with from the generating station to the wiring specifications, and in summing up the case a list of advantages to be derived from the change seems apparently unanswerable. Perhaps the reason for the continued use of the direct-current service is that stated in the introduction to this paper, that although electricity has been used for lighting and power on board ship for a number of years the question of economy in its use and application has had comparatively little consideration. 15,000 words.—*Journal of the American Society of Naval Engineers,* February.

Boilers Fired with Liquid Fuel.—An abbreviated translation of a paper by Major Giulio Fumanti, of the Italian Corps of Naval Architects before the first Congress of Marine Engineers held in Rome Nov. 12, 1911. The paper is evidently a complete treatise on the subject, and while little new matter is presented, the arrangement is especially good and complete from the standpoint of the naval engineer. Although the difficulties in using oil fuel, as stated, are high cost and difficulty of obtaining a regular supply, the advantages more than outweigh these, especially for naval vessels. Much care must be exercised in guarding against fire and shells, but these can be guarded against to some extent by using double-bottom tanks for storage and pumping to boiler rooms as required. The author favors the steam atomizing system for regularity of service. Figures are given showing time required for raising steam for starting or for full speed from time of giving orders and other like situations. In merchant service fuel consumption is stated to be 1.1 to 1.0 pounds per indicated horsepower per hour. 2,500 words.—*Engineering,* February 2.

Note on the Performance of Marine Turbines at Reduced Speed.—By E. Buckingham.—This article is as much a study of design of marine turbines for naval service as it is a note on their performance. For it is the purpose of the study of operating conditions at reduced speeds to design with better regard for that very essential feature of modern naval service. It is well known that while at full power turbines may show an acceptable performance from the standpoint of economy, it has so far been a very different thing at reduced speeds. So well is this known and generally accepted that separate cruising turbines have been installed where the necessity of the case demanded and space permitted. The purpose of this article is the determination of pressure distribution at reduced power and the relation of the pressures to the steam flow with their applications to design of turbines for economical service. These have been accocmplished as far as data at hand have furnished grounds and precision of measurements have permitted the deduction of a rule. From trials on turbines of the Salem and North Dakota, and comparison with reliable authorities on turbine design, the pressure distribution at reduced power has been determined and its relation to steam flow discovered to be approximately as follows: "When the steam flow is cut down by nozzle regulation, the absolute pressure at every point in the turbine except close to the condenser is reduced in the same proportion as the steam flow, if the feed to the steam chest is kept uniform in quality and pressure." Applications of this rule to practical design in several bearings are then taken up and explained. 5,600 words.—*Journal of the American Society of Naval Engineers,* February.

The Telefunken System of Wireless Telegraphy.—A detailed description of the apparatus of this most widely adopted system of wireless telegraphy. It was originally evolved in Germany, where, after the amalgation of two companies which had carried on business in wireless telegraphy separately, it received the name Telefunken. The system represents a combination of the Braun-Siemens and the Slaby-Arco systems, and has been built up on the researches and inventions of two well-known German scientists, Prof. Slaby, of Berlin, and Prof. Braun, of Strassburg, the latter of whom received the Nobel prize for physics in 1910. Of the 1,500 stations in operation at the beginning of 1909, 673 were Telefunken stations. The largest standard type of station on the new Telefunken system is said to require a primary alternating current energy of about 40 kilowatts. Radiograms sent in a southerly direction from Germany have been picked up by steamers as far as 2,500 miles distant, and in a westerly direction as far as 3,200 miles. In this system the instruments may be tuned very accurately and the variously tuned transmitters easily distinguished from one another by their notes, which are musical in their purity. The range of tones possible varies from 200 to 2,000 vibrations per second. The article contains a detailed description of transmitters and receivers, signal call apparatus and sound intensifier, with photographs of different sizes of sets made both for land and marine work. 6,700 words.—*The Steamship,* March.

Engineering Works at the Rosyth Naval Dockyard.—This, the second instalment of the series, continues the description of the concrete construction of the river walls and piers of this new naval station. The details of the work are given with some degree of completeness, the assumed conditions and designing factors furnishing satisfactory data for similar work. 2,100 words.—*Engineering,* February 2.

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Confronted by the most appalling disaster in the history of navigation, shipbuilders and navigators can no longer fail to recognize that their oft-asserted mastery of the sea is far from perfect. Great faith has been placed in the achievements of the modern shipbuilder, and the prudent navigator has feared nothing at sea but the land and unseen dangers. Even the timid ocean traveler has almost lost sight of the element of risk involved in the hidden menaces so long eluded by the skill of seafaring men, until at a blow one of the mightiest creations of naval architecture has been stricken and its ghastly toll exacted.

The *Titanic* was side-swiped, and the blow was dealt by an iceberg unseen until scarcely more than a ship's length ahead. The inability to detect an unlooked-for hidden obstacle in the path of the vessel at night, coupled with high speed and large size of the vessel, which mean a tremendous force for the thin shell plating of the ship to resist in a collision, all tend to make such a result inevitable. Overwhelming as the disaster is, from it must come an immediate and widespread development towards greater safety in ship construction, safer methods of navigation and safer appliances for preserving life when a ship is thrown upon her own resources under the most disadvantageous conditions.

In the first place, outside of collisions, there is little for the modern steamship to fear. Other risks have been practically eliminated. Even collisions, when between two vessels, have never proved so disastrous, because they usually occur in fogs when the ships are running at reduced speed, and the less damaged ship is usually able to assist the other. Much has been done by the United States Revenue Cutter Service in the location and removal of derelicts, and undoubtedly this work will be steadily pushed forward. There remains, however, the menace of the iceberg, which is still only a half conquered foe, and which has just proved its terrible destructive force. Icebergs, however, are not so numerous that they could not be located and traced with considerable certainty, so that ice regions could be avoided in regular ocean travel if the proper precautions were taken.

Even the greatest precautions in eliminating as much as possible the causes for collisions should not in any way deter every effort toward utilizing every means of protection for passenger ships from damage by collision. The part of the ship which has always been considered as the most likely to be injured by collision is some part of the bow, and the provision of a collision bulkhead and the use of transverse watertight bulkheads separating the holds in the forward part of the ship has been expected to give sufficient protection against a head-on collision. In most cases, if the bulkheads are absolutely watertight and of sufficient strength, this has proved a sufficient precaution; but as the speed and size, and, consequently, momentum of the ship when under way, increase, there is very good reason for subdividing the forward part of the vessel still further by the introduction of either a center line bulkhead in the forward holds, or by the use of an inner skin extending up to the waterline. The weights involved by such design, and the question of stability in the event of damage to one side of the ship only, must, of course, be carefully treated, as in warship design.

Side-swiping a vessel is an accident which has almost never happened, but when side-swiping extends for a considerable length of the ship, a system of protection by transverse watertight bulkheads is of little use. Some protection against such an accident can be obtained, as was done in the *Lusitania* and *Mauretania,* by the use of wing bunkers, with the longitudinal bunker bulkheads made watertight or virtually in the form of an inner skin to the vessel. This type of construction can be used in almost any ship, and if longitudinal framing is used with a corresponding saving in weight of the outer structure the additional weight of inner longitudinal bulkheads through the boiler space would not be so serious. Some additional saving in weight could also be obtained by the use of watertube boilers in place of the Scotch boiler, which has been steadfastly adhered to in merchant vessels.

Improved Engineering Specialties for the Marine Field

Life-Saving Appliances

The loss of life in the *Titantic* disaster emphasizes more strongly than ever before the absolute necessity of equipping all ships with the best and most efficient life-saving equipment that can be obtained. Only recently some new products along this line have been placed on the market by the Welin Davit and Lane & De Groot Company, Con., Long Island City, which are worthy of careful consideration.

Fig. 1 shows a ring-buoy that has the same appearance as the common type but differs greatly in construction. The ordinary ring-buoy now in use, made of cork, absorbs a great deal

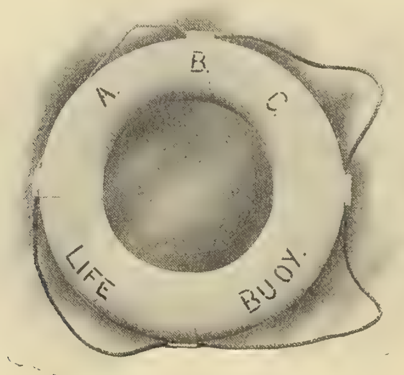


FIG. 1

of moisture, and therefore rots from the inside. The necessity of painting these every year in order to keep up their appearance and preserve them adds considerably to the weight, so that after a few years they cannot always be relied upon. The A. B. C. ring-buoy is made up in the same sizes as the regular cork one but is about 20 percent lighter in weight, though double the strength on account of it being made up of solid Balsa wood, turned to perfect shape and treated with an impervious solution which prevents the penetration of all moisture and water. The canvas cover is also of better quality

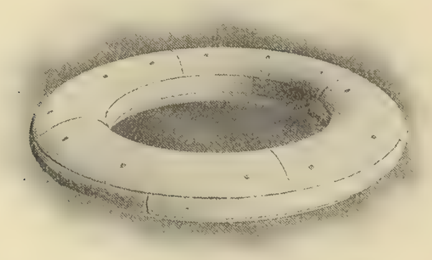


FIG. 2.—CONSTRUCTION OF A. B. C. LIFE BUOY

than that used on the cork ring-buoy, and if painted like the cork one it may in time gain weight, due to the paint but not due to the absorption of water. Should this accumulation of paint amount to 3 pounds, which would be an unusual condition, the A. B. C. ring-buoy would then weigh no more than the cork one, as it is 3 pounds lighter than that called for in the navy specifications. The superior durability of this buoy is therefore manifest.

The A. B. C. life raft, Fig. 2, is another illustration of what can be accomplished with this light and strong wood. This raft consists of about 50 board feet of wood and will support eight persons in the water. Yet, notwithstanding this, one man can easily handle this raft, and if need be throw it overboard from the deck of a yacht or motor boat, a type of boat for which it is particularly adopted. Experience has shown that there is very little room to spare for the regular metallic life raft on such small craft, and, further, there is no way of launching such a raft when needed. As all life-saving appliances on motor boats are needed quickly in case of accident, the value of the A. B. C. life raft is apparent. It is made in three sizes, varying in length from 4 to 7 feet.

FIG. 3

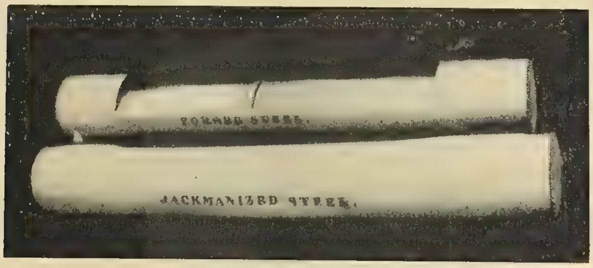
Besides the ring-buoy and life raft just described the products of this company include the A. B. C. life preserver, which has been on the market for a number of years. These are made of Balsa wood, and are one-third smaller and lighter than the ordinary cork belt, which makes them of particular value to ships carrying a great number of persons. It is well known that life preservers made of cork, tule or other material absorb moisture and retain it, and there is therefore the constant necessity of repairing and renewing the covers, due to mildewing and rotting, principally from the inside. The life preserver manufactured by this company, however, it is claimed, does not absorb moisture on account of its waterproof coating, and there is therefore no opportunity for destruction from the inside. By actual test the company states that it has been proved that this life preserver will outlast three or four times the ordinary cork belt and will retain its buoyancy indefinitely.

One of the most important life-saving appliances manufactured by this concern is the Welin quadrant davit, well known for its ease of manipulation, reliability, adaptability for launching boats under all conditions and for the saving of deck space, both longitudinal and transverse, which they permit. The company also manufactures a complete line of standard lifeboats of both metal and wood, which involve special improvements accepted and commended by the United States Government inspectors. Another product of the firm is also a type of non-sinkable and non-corrosive yacht and motor boats, built of steel, bronze and Monel metal.

After June 1 the firm will be known as the Welin Marine Equipment Company, and its president states that the company will be pleased to give estimates without charge on up-to-date boat and launch equipments, and also to assist in drawing the designs if furnished with the necessary deck plans of the ship under construction.

"Jackmanized" Steel

Joseph Jackman & Company, Ltd., of Persberg Steel Works, Sheffield, manufactures a special steel for dredging work called "Jackmanized" steel. After severe tests this has proved to be eminently suited for dredger pins, bushes, tumbler shafts, etc. This steel, it is claimed, can be forged to any desired dimensions and still retain its hardening face. "Jackmanized" steel is a substitute for case-hardened iron and steel, and only requires to be heated and immersed in water or oil to be intensely hard on the surface to a depth of 1/8 to 3/16 inch, the center of the bars, or turned pins, remaining soft and tough, thereby retaining almost their original strength before



hardening. The illustration clearly shows the comparative quality of "Jackmanized" steel. It depicts two lower tumbler shafts taken from a double ladder dredger. Both shafts were put to work in December, 1902, and taken out November, 1903; each when put in measured 9 inches diameter by 5 feet 3 inches long and weighed 10 cwt. The actual time at work dredging is officially given as:

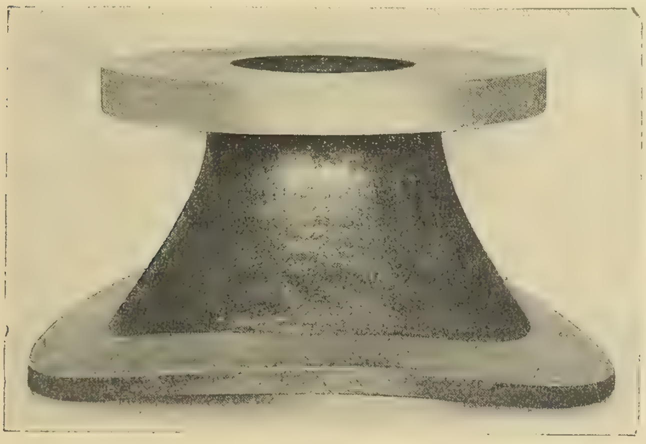
Mild steel, 2,255 hours (worn down 2 inches).

"Jackmanized" steel, 2,521 hours (worn down 13/16 inch).

Another feature which will be readily noticed is the appearance of the two shafts, the former being very much reeded, whereas the latter is perfectly smooth and sound, although it had worked 266 hours more than the ordinary steel shaft.

Taylor Seamless Forged Steel Boiler Nozzle

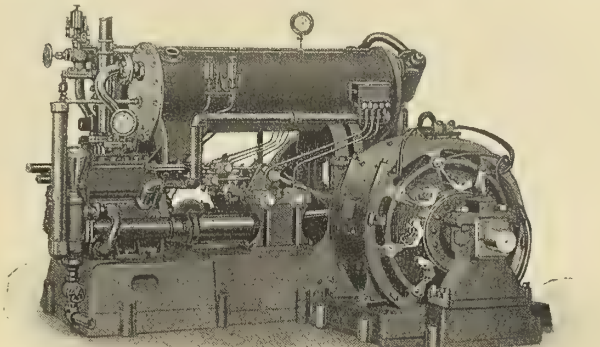
The American Spiral Pipe Works, of Chicago, Ill., manufactures a boiler nozzle which is forged from a single piece of open-hearth steel without a weld. The proportions of this nozzle can be seen from the illustration. A special process is used for forging the nozzle from a single piece of steel by



which the neck just under the flange is made heavier than the remainder of the body, thus providing against the working strains which are greatest at this point. The distance between the flanges is sufficient to allow the insertion of bolts from the under side, thus obviating the use of studs. The saddle flange is of sufficient diameter to enable the use of power riveters for attaching the nozzle. The nozzle may be heated and the saddle flange bent to the required circle with no separate part to become loosened when heated. It is claimed that this type of nozzle forms the safest and most reliable connection between the boiler and high-pressure piping.

The Allen Dense Air Ice Machine

The Allen dense air ice machine, manufactured by H. B. Roelker, 41 Maiden Lane, New York, is so constructed that it can be placed conveniently in the main engine room of a steamship, where it can be attended to by the regular engineers along with their usual work while the meat-room or refrigerated compartment is in a distant part of the vessel. The machine utilizes only common air at reasonable pressures and only machinery similar to usual steam engine machinery, there being no auxiliary pumps or other machinery outside of the ice machine. Instead of taking air from the atmosphere or from a cold room and after refrigeration discharging it again into the room, the Allen machine keeps a charge of air at 60 pounds gage pressure in the machine and the conveying and refrigerating pipes, and uses this supply of air over and over again, compressing it in the air compressor, then cooling



it in a copper coil surrounded by circulating water, expanding it in the expanding engine to reduce the temperature and pushing it when cold through the conveying pipes to the cold room, where it also remains inside the pipes and does its refrigerating by radiation through the surfaces of the pipes, then it passes back through the same cycle and repeats the performance.

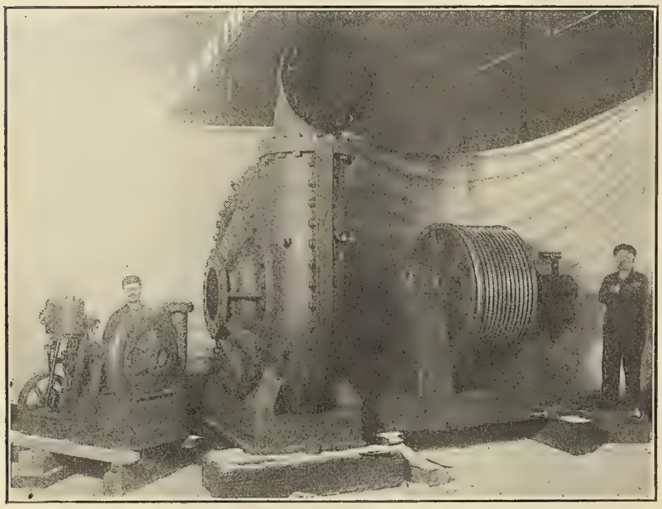
Power for the whole apparatus may be supplied by either a steam cylinder or by an electric motor. The machine illustrated is a 3-ton machine, electrically driven. The various parts of the machine, besides the power plant, consist of the air compressor cylinder, which compresses the air to about three times the entering pressure, and thus heats the air. The compressed hot air then passes through a copper coil in a bath of water, which cools the air to the temperature of the cooling water. Next the air passes through a return air cooler, which further cools the compressed air by means of the cold air returning from the meat-house or refrigerated compartment. After this the cooled compressed air is admitted to the expander cylinder till it fills one-third of the volume of the cylinder. It is then shut off, and the piston, continuing its passage to the end of the cylinder, expands the air to about the pressure at which it entered the compressor. This expansion cools the air about as much as the compression heated it, therefore leaving the air at a temperature of practically 60 degrees F. below zero. This air is then discharged into a well-insulated pipe, which conveys it to the compartment which is to be refrigerated.

The only additional part in the condensed air ice machine is the so-called primer pump, a simple small plunger pump, which compresses the atmospheric air into the machine at

starting and makes up the losses caused during the running by leakage from stuffing-boxes and pipe joints. There are two traps, which remove refrigerating oil and water from the air and keep it pure while passing through the pipes.

18-Inch Hydraulic Dredging Pump

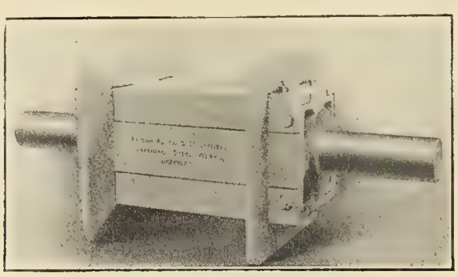
The Kingsford Foundry & Machine Works, Oswego, N. Y., has recently constructed for the Chicago, Burlington & Quincy Railroad an 18-inch hydraulic dredging pump, a view of which is shown herewith. The pump has a manganese steel liner 1



inch thick and a shell 2½ inches thick. The total weight is 33,000 pounds and the total height 10 feet 5 inches. The small pump shown in the photograph is a 5-inch side suction pump connected by a silent chain to a 6-inch by 6-inch vertical engine. The outfit is used for priming the large pump.

Steel in Dredger Building

In our last dredger number we called attention to the increasing use of special steels in dredger construction, notably the use of manganese steel. Herewith we show a cast steel dredger tumbler and shaft with renewable corner pieces

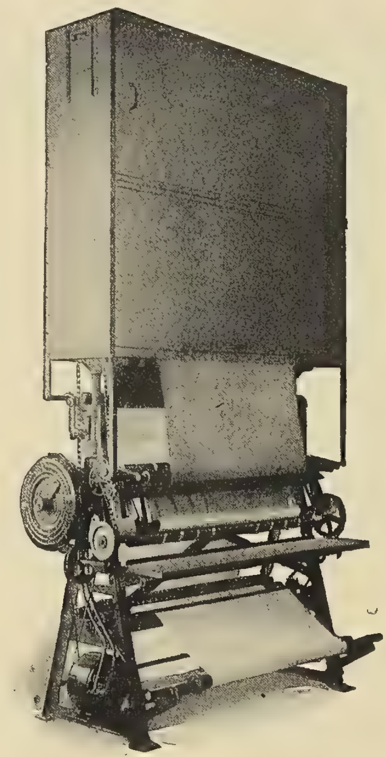


of Allen's manganese steel, manufactured by Edgar Allen & Company, Ltd., Imperial Steel Works, Sheffield. This company also makes dredger pins of various sizes and designs of the same material, and dredger buckets and links with Allen manganese steel bushes.

A Valuable Accessory to the Blue Print Room

Sensitized blue print paper is very easily affected by atmospheric conditions, so that the sooner it is used after coating the better are the results. The C. F. Pease Company, Chicago, Ill., has placed on the market a machine which coats the paper at the rate of twenty-five or thirty 50-yard rolls per day, enabling the operator to start the coating machine and do his blue printing at the same time.

This machine, called the "Simplex," occupies a space of only 3 feet by 5½ feet, and can be set up against the wall. The apparatus is entirely self-contained, and is operated by a ¼-horsepower variable speed motor, controlled by an electric speed changing device, so that any speed can be instantly secured, according to the quality and thickness of the paper that is being coated. A roll of uncoated paper weighing 150 pounds is placed on the receiving spindle. The paper is then carried under the rubber-covered coating roller up through the drying oven, which may be heated either by gas, electricity or steam, after which the sensitized paper is automatically wound



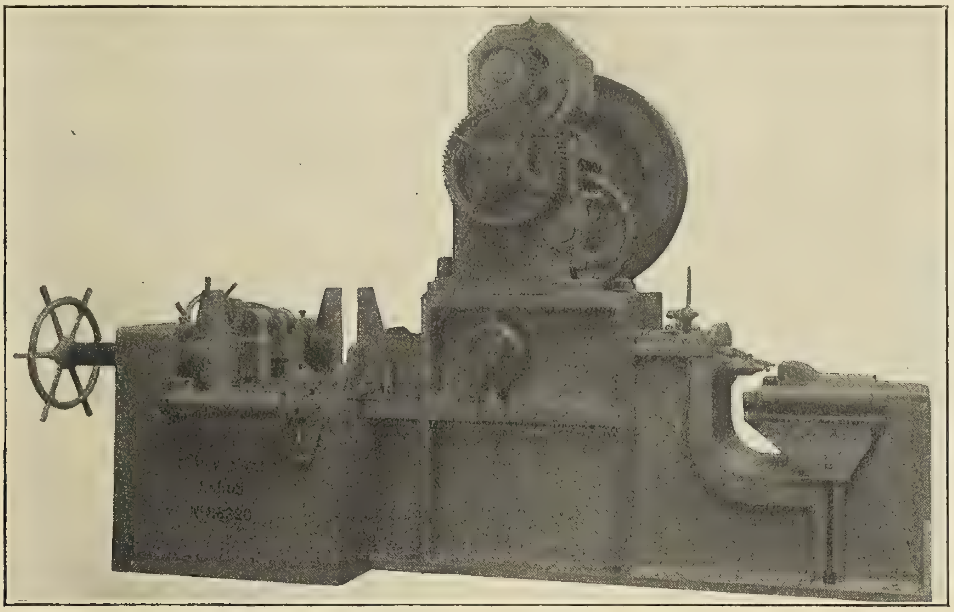
up in a tight roll and in any length desired. An automatic measuring device is used, which is so arranged that just before the desired length of paper is reached a bell is struck, notifying the operator in time for him to cut off the paper and start a new roll.

With this apparatus it is claimed that it is possible for the operator, within twenty minutes after the machine is started, to have a fresh roll of paper ready for printing, and every fifteen or twenty minutes thereafter as long as the machine is in operation. The maximum capacity is twenty-five to thirty 50-yard rolls of paper per day. The manufacturers claim that the cost of drying by gas does not exceed 5 cents per hour, while the cost of operating the ¼-horsepower motor is nominal. The standard machine is of a width to coat paper 42 inches or narrower, but it is applicable for any desired width; in fact, machines of this type have been built for coating paper 66 inches wide, or for coating a 30-inch and 36-inch roll side by side.

Scriven's Combined Horizontal Punch, Beam Bender and Bulb Shearing Machine

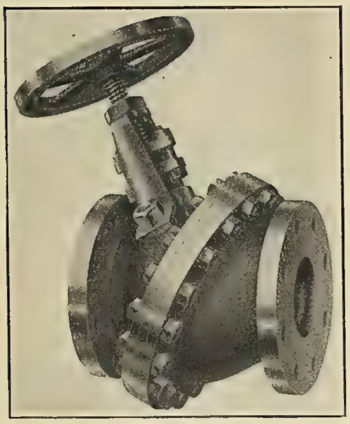
Our January number contained a very complete description of the combined punch, bending and shearing machine manufactured by Scriven & Company, of Leeds, for beam-shed work in a shipyard. Herewith we reproduce a photograph of the machine showing the details. The machine consists of a twin horizontal punch at one end and a combined beam bending and bulb shearing device at the opposite end The twin

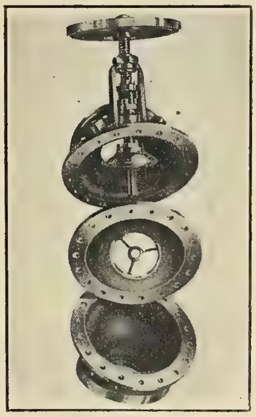
punch permits punching two different sized holes in the same bar without changing the punch or without any extra handling of the bar. The bulb shearing apparatus is designed to take off the bulb from a beam for a length of 6 inches or shear out a piece of the leg 6 inches at one cut. The beam-bending device has a capacity of handling beams 15 inches deep. The whole machine is of massive design, capable of doing the maximum work continuously at a speed of thirty strokes per minute at both ends.



Patterson-Allen Forged Steel Valve

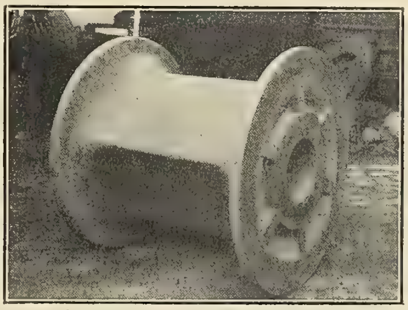
A special line of valves for superheat and other high-pressure installations is manufactured by the Patterson-Allen Engineering Company, New York. The construction of the valves is shown in the illustrations. They are made entirely from forged steel boiler plate with Monel seats, Monel disks and nickel steel steams. They are said to be one-third lighter than cast steel valves of equal capacity. The valves are all forged in steel dies, which it is claimed absolutely guarantees uniform thickness throughout, and they are required to stand a hydrostatic test pressure of 1,500 pounds to the square inch.





Special Steel for Dredge Machinery

Experience has shown convincingly that for such parts of dredging machinery as are subject to severe wear and tear no other material gives such good results as the recently-introduced alloy steels, the characteristics of which are great toughness and durability. Such parts as pins, bushes and bucket lips are made by Thomas Firth & Sons, Ltd., Norfolk Works, Sheffield, of "Firth's Norfolk" manganese steel, which offers great resistance to wear, while being also characterized by uniform hardness and toughness throughout, a combination most essential in dredger work, since there is no fear of unexpected or premature breakage of parts made from this material. For tumblers and buckets this firm also makes a special quality cast steel, while the links can be supplied either cast or forged.

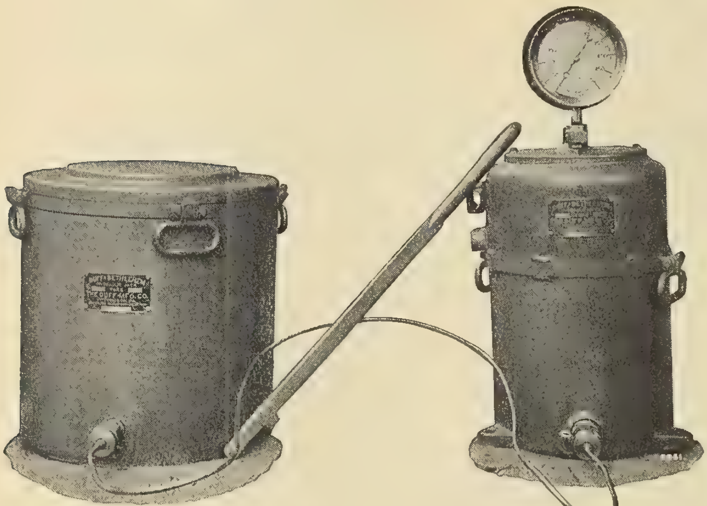


A Powerful Jack

The United States Government has recently purchased from the Duff Manufacturing Company, of Pittsburg, Pa., a Duff-Bethlehem hydraulic jack capable of lifting a load of 500 tons. This jack, which is intended for use in the Washington navy yard, is of the independent pump type, consisting of two distinctly separate parts, one containing the water reservoir with its pump chambers and the other the ram or lifting mechanism. Flexible copper tubing, capable of withstanding a pressure of 10,000 pounds per square inch, connects the two parts. This arrangement permits of the ram being placed in any position where there is sufficient room for it to rest, while the pumping mechanism can be placed at a sufficient distance to allow the operator plenty of working room.

The pump is of the improved Duplex type, providing an accumulative stroke on the upward motion of the pump piston and a working stroke on the downward movement. The pump is so arranged that it is claimed a light load can be lifted five

times as fast as a heavy load. This differential speed is automatically spring controlled, and requires no regulation of valves by the operator. The high speed is used for loads up to 35 percent of the capacity of the jack. In lifting loads greater than 35 percent of the total capacity the spring-controlled valve automatically opens at the predetermined pres-



sure per square inch, and the pump becomes single acting, working on the down stroke only.

Another feature of this jack is the gage, which shows the exact lifting pressure that is being exerted. This gage acts as a scale, and registers in tons the weight that is being lifted.

North British Dredger Hose

A dredger hose of exceptional size, manufactured by the North British Rubber Company, Ltd., at Castle Mills, Edin-

burgh, is shown in the accompanying illustration. This is used for suction work in disposing of the spoil from dredging.

Mr. T. M. Cornbrooks has been appointed chief engineer of the Maryland Steel Company, Sparrows Point, Md.

Dr. Rudolph Diesel, D. E., D. Sc., director Verein Deutscher Ingenieure and inventor of the Diesel engine, was made honorary member of the American Society of Mechanical Engineers April 30.

Chief Engineer A. G. Erickson, of the Metropolitan Line steamship *H. M. Whitney*, recently met with a rather painful accident which caused him to lay off for one trip, but we are pleased to find that he has completely recovered.

Mr. John Dickey Culbertson, second vice-president and treasurer of the National Tube Company, died suddenly at Pittsburg, Pa., on March 13.

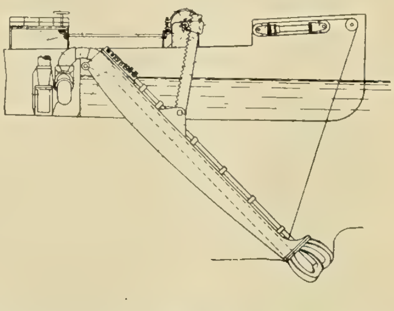
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,013,669. SUCTION DREDGER. FRED LOBNITZ, OF CROOKSTON, SCOTLAND.

Claim 1.—In a suction dredger the combination, with a ladder having a suction pipe or passage, of a rotating cutter carried by said ladder,



means for operating the cutter, means for holding the cutter down to its work, and means for allowing said holding means to slip when a certain pressure is exerted thereon. Nine claims.

1,013,928. APPARATUS FOR LOADING VESSELS. JOHN T. CLARK, OF NEW YORK, N. Y.

Claim 2.—In an apparatus, a cage, a plurality of movable members carried thereby, means co-operating with the respective movable members for tilting said movable members in oppositely inclined directions, and means for controlling the vertical movement of the cage. Seventeen claims.

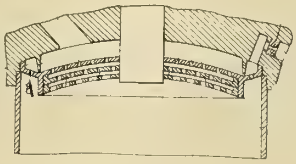
1,014,014. AUTOMOBILE TORPEDO AND METHOD OF AND APPARATUS FOR ITS PROPULSION. HUDSON MAXIM, OF HOPATCONG, N. J.

Claim 4.—The method of generating a motive fluid for torpedoes and the like, which consists in subjecting a self-combustive fuel to an initial pressure at the time of ignition, burning said fuel under pressure, and controlling the rate of combustion by controlling the pressure under which the burning takes place. Twenty claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

781. HEATING DEVICES FOR USE IN TORPEDOES AND THE LIKE. SIR W. G. ARMSTRONG, WHITWORTH & COMPANY AND W. H. SODEAU.

The air or other gaseous supporter of combustion, on entering a combustion chamber, passes through one or more perforated deflector plates,



one of which is adapted to form, with the head of the combustion chamber or a part carried by it, a conduit from which water or other vaporized liquid is discharged on to the walls of the chamber.

29,896. VESSELS DRIVEN BY SCREW PROPELLERS. F. G. PRATT, LONDON.

This invention has for its object the arrangement of power and transmission gear so that a maximum of power can be got into a vessel of minimum size whereby a material increase in speed and economy in running results. The propellers are arranged below the keel line, one above the other in echelon. By this arrangement less shafting outside the vessel is presented to the water than if the shafts were arranged in the same horizontal plane. Furthermore, a better distribution of machinery weights is obtained.

2,288. SECURING THE RUDDERS OF SHIPS WHEN DISABLED AT SEA. C. J. W. AGERSKOW, KINGSTON-UPON-HULL, FROM S. FIELDWOOD, CALCUTTA.

At each side of the rudder quadrant two stop blocks are fixed, each being situated so as to allow the necessary normal movement. Each block has a buffer with cushioning spring for absorbing shock when the quadrant comes in contact with it, and also on each block is mounted a catch which projects toward the quadrant. When the rudder becomes uncontrollable from any cause, except breaking, the rudder, swinging beyond the point to which it would move under control, causes the quadrant to strike the buffer and the catch allows the side of the quadrant to pass, but immediately after drops, engages and retains it.

International Marine Engineering

JUNE, 1912

Twelfth International Congress of Navigation

The Twelfth International Congress of Navigation was opened Thursday morning, May 23, in the Metropolitan Opera House, Philadelphia, Pa., by President Taft. Hon. J. Hampton Moore, president of the local organization commission of the Congress, presided at the opening exercises, where addresses were delivered by President Taft, Governor Tener, Mayor Blankenburg, Brig.-Gen. Bixby and Prof. V. E. de Timonoff.

After the opening exercises the regular sessions of the Congress began on Thursday afternoon at the Bellevue-Stratford Hotel. The work was divided into two sections—Inland Navigation and Ocean Navigation—the meetings of both sections being carried on simultaneously.

The Twelfth Congress of Navigation was organized by the International Association of Navigation Congresses, having its permanent headquarters in Brussels, Belgium, and governed by a commission composed of delegates appointed by the governments of the States contributing to the support of the association. The permanent International Commission, as now organized, is made up of three executive officers, namely, two presidents and a general secretary, who are Belgians; seven gentlemen who have acted as general secretaries of previous Congresses, and eighty-nine members appointed officially by the several governments that support the association. The members of the Commission include, particularly in the great continental countries of Europe, the highest authorities in each country on questions connected with the planning, construction and operation of works for the improvement of inland and ocean navigation. The members from the countries which originally formed the association have been, in general, active participants in all the Congresses of Navigation since 1885, and the present permanent organization of the association is due to them.

The object of the association is to promote the progress of inland and ocean navigation by keeping its members informed regarding the most recent experience in the construction of great public works for navigation and the technical improvements in these works, and by discussion of plans concerning all important questions bearing on technique or a policy directly connected with such works. It accomplishes this object by organizing navigation congresses; by publishing papers, proceedings and various other documents, and by acting as an international bureau of information through which members may obtain the most recent information on all subjects connected with navigation works. International Congresses of Navigation have been held at various intervals since 1885 in Belgium, Germany, Austria, England, France, Holland, Italy and Russia. These congresses have been of the utmost value in furthering the general progress of work in the interest of navigation, and in studying the results of experience in the constantly arising theoretical and practical questions connected with waterway construction and with the technical, industrial and commercial development of inland waterways and sea ports.

For discussion at the Twelfth International Congress of Navigation three subjects were chosen for each of the two sections. Individual papers on these subjects were prepared by experts from nearly every maritime country in the world. These papers are published in full in the proceedings of the society, but before publication they were submitted to a reviewer or general reporter appointed for each question, whose duty it was to present an analysis of all the papers transmitted to him, giving his own views and personal opinion regarding the subject and drawing up a conclusion to be voted on at the Congress. These reviews are translated and printed in three different languages, and are distributed to the members of the Congress. In the following we give abstracts of the reviews presented before the Congress by the general reporters, together with abstracts of the summaries formulated by the general reporters in analyzing the communications submitted on the various subjects selected for each session of the Congress:

1st Section: Inland Navigation

1st Question: Improvement of Rivers by Regulation and Dredging and, if needs be, by Reservoirs—Determination of the Cases in which it is Preferable to Resort to Such Works rather than to Canalization or the Construction of a Lateral Canal

GENERAL REPORT BY HENRY C. NEWCOMER*

Ten papers have been submitted on this question, as follows:

No. 2, Herr Geheimer Oberbaurat Dr. Ing. Sympher, Wilhelmstrasse, 80 Berlin W. 66.

No. 3, Mr. E. Lauda, Diplomierter Ingenieur, Sektionschef im K. K. Ministerium für öffentliche Arbeiten in Wien.

No. 3 bis, Mr. Bohuslav Müller, Ingénieur en chef du Gouvernement Imp. et Royal de Bohême, attaché à la Commission pour la canalisation de la Vltava et de l'Elbe en Bohême, Prague.

No. 4, Major Wm. W. Harts, Corps of Engineers, U. S. Army, Customhouse, Nashville, Tenn.

No. 5, Mr. Wm. B. Landreth, Civil Engineer, formerly Special Deputy State Engineer, 20, Gillespie Street, Schenectady, N. Y.

No. 6, Mr. Kauffmann, Chief Engineer of the Ponts et Chaussées, rue Dugommier, 9, Nantes.

No. 8, Mr. Eugene de Kvassay, Ministerial Counsellor, Chief of the Hungarian State Water Survey.

No. 9, Mr. Charles Valentini, Chief Engineer of the Genio Civile, at Bologna.

No. 10, Mr. R. H. Gockinga, Chief Engineer of Waterstaat, at the Hague, and Messrs. H. Baucke, E. Van Konynenburg and Jonkheer C. W. Van Panhuys, Engineers of the Waterstaat at Nimegen, Maestricht and Zutphen.

No. 11, Mr. V. E. de Timonoff, Professor at the Imperial Institute of Lines of Communication, Director of Statistics and Cartography of the Lines of Communication, etc., 7 Perspective Ismailovsky, Saint-Petersburg, and Mr. G. H. Kleiber, Engineer of Lines of Communication, in charge of dredging, Stoliarny, 11, Saint-Petersburg.

This question opens up a very wide field for discussion. Its full treatment would require a detailed account of all the methods of river improvement as applied either singly or in combination to streams of different characteristics, showing the advantages and defects of each type, the limits of its application, and the physical and commercial conditions that determine the choice of methods under different circumstances. Such an elaborate investigation is obviously impracticable within the brief limits of a report, and the reporter must therefore confine himself to a very condensed statement upon the general subject or direct his attention to a more detailed examination of some features that may be of special interest to him.

* Lieut. Col., Corps of Engineers, U. S. A., Pittsburg, Pa.

It is quite apparent that no single method of improving the navigability of rivers is generally accepted as having merit superior to the others. While conditions in one country give special prominence to one method, the situation in another country leads to different results. In some cases increased navigation facilities can be supplied in several ways, while in others any adequate improvement is practically limited to one form of procedure.

It is believed that more emphasis should be placed upon the financial side of the problem. Usually the improvement that it is physically possible to make varies through a wide range, depending not only on the method employed, but also on the amount that can be expended, and it is necessary to determine the cost that is best proportioned to the commercial benefits. As the waterway problem is essentially one of transportation, it may even be advisable in some cases to inquire whether the commercial needs may not be best satisfied by railroad construction. This consideration would, of course, apply with greatest force in those instances where the authorities or parties conducting the investigation are in a position to provide whichever form of transportation is deemed most desirable.

It may be of some interest to refer to the results of investigations made a few years ago concerning the improvement of the Ohio and Mississippi Rivers by dredging. The Ohio River was examined with a view to its improvement by canalization to secure depths of 6 or 9 feet, and also to determine whether these depths could be maintained by dredging in the lower part of the river, for a distance of about 190 miles, from Green River to Cairo, where there is a slope of about 3.7 inches per mile. The conclusion was reached that either 6 or 9 feet could be maintained by dredging, and that the dredging would cost about 38 percent less than canalization for a depth of 6 feet, and about 60 percent more than canalization for a depth of 9 feet. The improvement of the Ohio by storage reservoirs has also received some consideration, and it has been ascertained that the entire run-off at Pittsburg, if completely controlled, could not give the desired depth of 9 feet, as the mean annual discharge corresponds to a less depth than this.

It is well known that a depth of 9 feet has been maintained by dredging in the Mississippi River below Cairo for a number of years, with occasional slight exceptions. Above Cairo to St. Louis the project provides for a depth of 8 feet to be obtained by dredging and regulation. The agitation for a deep waterway from Lake Michigan to the Gulf of Mexico led to an investigation of the practicability of securing a depth of 14 feet in the Mississippi River below St. Louis. All methods of improvement were considered, and Mr. Landreth has given the adverse conclusions reached with reference to the use of reservoirs. The Board of Engineers that conducted the investigation decided that dredging could maintain a depth of 14 feet below Cairo and St. Louis. The estimated costs, however, ran very high, being about $12,300 (£2,500) per mile per year above Cairo and $3,100 (£630) per mile per year below Cairo.

The divergence of views expressed, especially on the subject of dredging, makes it doubtful whether any conclusions can be framed that will meet with general approval in all respects, but the following propositions are submitted for the action of the Congress:

1. Under the widely varying requirements of navigation, and the very different physical conditions of slope, discharge and nature of bed, no single method of improving the navigability of a river has superior advantages in all cases, but each may in turn be found most satisfactory under special conditions.

2. The choice of a method of improvement depends not only on the capacity of the stream for improvement by the different methods, but also on the volume of commerce to be benefited and the resulting cost of transportation, including interest on the cost of improvement, maintenance charges and the cost of carriage.

3. The slope, discharge and nature of bed and banks are the main factors determining the limits and the cost of improvement by the ordinary methods of regulation, dredging and canalization, and the prospective tonnage is the main factor determining the justifiable expenditure.

4. Regulation and dredging, either singly or in combination, are apt to be more uncertain and limited in their results than canalization, but they are usually preferable when the needs of navigation can be satisfied by these means. Otherwise it is generally advisable to employ canalization, using fixed or movable dams, depending upon the limitations imposed by flood conditions, and the requirements of navigation.

5. Lateral canals are usually less desirable than canalization, but may be required under some conditions.

6. Reservoir control of stream flow, sufficient to meet the needs of navigation, is usually impracticable within reasonable limits of cost, but in rare cases it may be used to advantage to supplement other methods of improvement.

7. It is desirable that the following steps be taken with a view to perfecting the methods employed for improving the navigability of rivers:

(*a*) That scientifically organized special studies be undertaken by sundry nations, on rivers with different regimens, in order to observe the degree of navigability which it is possible to attain by the application of various methods of improvement and to determine the factors which govern the cost of the corresponding works.

(*b*) That hydrotechnic laboratories intended for the study, on small-scale models, of the life of rivers becomes of more and more extended use, and that they be supplied with the means necessary to experiment with the various processes for improving the navigability of rivers and, in so far as possible, in connection with the studies and works carried out on the rivers themselves.

(*c*) That the resolution of the Sixth Congress of Inland Navigation, voted at The Hague in 1904, be carried into effect, this resoultion calling for taking up, in connection with rivers having but one current, the study of a short, clear formulary, which shall be sufficiently complete and include the information necessary to define the characteristics of every river studied, from the double point of view of its regimen and its navigation.

(*d*) That the question of the improvement of the navigability of rivers having but one current, completed by those of the laboratory experiments and of the formulary, be kept on the order of business of the next Congress of Navigation.

2d Question: Dimensions to be Assigned, in Any Given Country, to Canals of Heavy Traffic—Principles of Operating—Dimensions and Equipment of the Locks

GENERAL REPORT BY ALFRED NOBLE*

Seven reports have been submitted on these subjects, presenting the results of investigations and of experience in several countries; arranged in their numerical order they are:

No. 13. In Germany, by Herr Geheimer Oberbaurat W. Germelmann.
No. 14. In Belgium, by Mr. P. Glaudot, Engineer of the Ponts et Chaussées.
No. 15. In the United States, by Col. H. F. Hodges, Corps of Engineers, U. S. A., Asst. Chief Engineer, Isthmian Canal Commission.
No. 16. In France, by Mr. J. Bourgougnon, Chief Engineer of the Ponts et Chaussées.
No. 18. In Italy, by Mr. Edmond Sanjust di Teulada, Senior Inspector of the Genio Civile.
No. 19. In Russia, by Mr. Nestor Pouzyrevsky, Engineer.
No. 20. In Sweden, by Col. Frederick V. Hansen, Corps of the Ponts et Chaussées, President of the Royal Administration of Hydraulic Motive Powers.

From the reports which have been briefly reviewed it appears that in Germany the cross-sections of canals have been

* Consulting Civil Engineer, New York.

fixed mainly with reference to boats having carrying capacities of 400 or 600 tons, these boats having the same cross-sections and differing only in length; the tendency, however, is manifest to provide for larger boats in certain cases, where connection is made with river traffic in which larger boats are used. The least wet cross-section is from 4¼ to 6½ times the immersed section of the standard 600-ton boat, and will permit such boats to pass each other anywhere; a clearance of 2½ feet or more is allowed between the keel of the boat and canal bottom when the canals are built. In Belgium the canals in the vicinity of the large industrial centers and their connections to tide water are being enlarged, or are to be enlarged, to pass boats of 1,000 or 2,000 tons capacity; but farther into the interior toward the French frontier, dimensions suitable for 300-ton boats are to remain standard. The least wet cross-section of the canals varies from 2.5 to 4.4 times the immersed section of the largest boat. In France there are two distinct types of canals; those of the first type, which are interconnected to a great extent, and embrace nearly all of the canals for large traffic, conform to dimensions established as long ago as 1879, and provide for boats having a carrying capacity of 300 tons; canals of the second type are of much larger dimensions, are adapted only for the larger valleys, and only two have been built up to the present time. It may be said, therefore, that the dimensions suitable for boats carrying 300 tons are adopted in France. The clearance under the loaded boats is a little more than 10 percent of the draft, and the wet cross-section of the canals is about four times the wet cross-sections of the typical 300-ton boat. In Italy, the dimensions now favored are based on the use of boats of 600 tons. In Sweden it is considered impracticable to fix standard dimensions, since local traffic conditions must govern in many cases. For the Trollhättan Canal the dimensions of the cross-section were fixed with reference to a boat drawing 13.12 feet with a clearance under the boat of 10 percent of its draft, and a wet section 4 to 4.5 times the wet section of the largest boat. In Russia the canals appear to be subsidiary to the navigable rivers, and their cross-sections depend on those of the largest boats traversing the rivers, which are taken to be 361 feet long, 52½ feet in breadth and draft of 5.9 feet, and a carrying capacity of 1,700 tons. The canal from the Don to the Volga is to have a bottom width of 140 feet and a wet cross-section area about four times the immersed section of the largest river boats. No standard dimensions applicable throughout the country exist in the United States. The only canals of large traffic are short canals passing around rapids in important lines of communication where the dimensions depend necessarily on the character of the traffic, in which one or two items usually predominate. Of the many small canals formerly operated only one, the Erie Canal, with a traffic of about 2,000,000 tons annually in boats of 250 tons capacity, carries even a moderate traffic, and this is to be replaced by the so-called Barge Canal, with boats of possibly 2,000 tons capacity, the most suitable dimensions of boats being still undetermined; the ratio of wet sections of the canal and boat and the clearance under the boat are therefore yet to be ascertained. If traversed by the largest boats the lock dimensions permit the ratio of wet section of canal to immersed section of boat may be as small as 2.5 to 1.

Among the advantages of large dimensions for canals may be mentioned:

(*a*) Lower cost of transporting goods. In order to make this fully available suitable port facilities should be provided for handling and storing freight, and suitable connections made with other waterways and with railway lines.

(*b*) The aid given by cheaper transportation to the development of trade which otherwise would not exist.

In order to make full use of these advantages it may be necessary to establish low rates of tolls or to make the canal free from tolls. The burden thus imposed on the State may be fully offset by the development of its resources and the increased revenue resulting therefrom.

The topographical conditions may prohibit the adoption of large dimensions, as noted by Mr. Bougougnon in regard to canals similar to the Marseilles-Rhone Canal, a type which he states is "only practicable from an engineering point of view in France in a small number of large valleys with a slight incline and with a large watershed." The dimensions of existing canals and the character of existing port facilities may control in planning new work, as in the case of the Nord Canal in France, where the conclusion appears to be accepted that the dimensions of canal suitable for 300-ton boats are the best. Where a new system is to be developed or old systems modified large dimensions appear to be favored, as, for example, in the adopted project in Italy in which the use of 600-ton barges is provided for; the system now under construction in Germany, providing for boats carrying 600 tons or more, or the New York State Barge Canal, which was designed for navigation by craft carrying 1,000 tons, and the enlargement of the principal Belgian canals to accommodate boats of 1,000 tons and upwards. The local conditions at the Trollhättan Canal have led to the adoption of dimensions suitable for craft carrying 1,350 tons, in Russia the use of canals to connect navigable rivers has resulted in still larger dimensions suitable for large river boats.

The term "principles of operating" has been interpreted in different ways by the several authors; your general reporter will allude, under this head, to ownership and operation, to the levy of tolls, to haulage, whether by monopolies or otherwise, to the development of ports, and to the organization of responsible transportation companies.

It appears to be agreed that waterways for large traffic must be owned and operated by the State or under State control. Tolls are not usually levied in sufficient amount to meet all the costs of constructing and operating the canals. In France they are free except in a few cases, and in the United States are absolutely free in all cases; in Sweden, however, it appears from Col. Hansen's paper that the tolls are expected to cover all costs. Data are not given in regard to the other countries reported on. Mechancial haulage is in use to some extent, both as a State monopoly and under concessions, and is generally believed necessary with heavy traffic. The furnishing of port facilities by the State or by municipalities is regarded as essential; the organization of large transportation companies is advocated in Italy and, it may be added, is regarded as very important in connection with the New York State Barge Canal in order that goods may be way-billed through from point of origin to destination when the waterway is only a link in the chain of communication. Monopolies for towing, operating under State control, are favored in the reports for Belgium and Russia, and a monopoly service has been provided by the municipality on the Teltow Canal in Germany.

In regard to the dimensions of locks, perhaps the most noticeable recent development is more general provision for locking two or more boats together; there is also a tendency to greater lifts, 21.3 feet to 22.3 feet having been adopted in the Nord Canal, one of 40.5 feet in the New York State Barge Canal and one or more in Germany of 65.62 feet.

The use of machinery for operating lock gates and sluices, long in use for locks of large dimensions, is being extended to smaller ones. Side ponds for saving water are in use in many places. Safety devices are alluded to as in use at the St. Mary's Falls Canals; these may be considered as of two classes, the first class consisting of means to avoid carrying away the gates and the release of water from the higher level, the other to means of closing the channel after such an accident. Both of these classes are dealt with by Col. Hodges. Your general reporter may be permitted to refer to what he considers a very

important item of canal equipment serving to reduce risks of accidents to gates, where the traffic is carried on in large ships, viz.: long approach or guide walls, provided with numerous snubbing posts for the purpose of assisting the crew of a ship in checking its speed and bringing it to a stop at a safe distance from the lock.

At the St. Mary's Falls Canals the approach piers above the locks are the side walls of the canals, which are vertical or nearly so, and extend about one mile; below the locks the piers extend 1,500 feet or more, and upon completion of the new canal now under construction this will be increased in the United States canals to more than 2,000 feet.

Since the opening of the first canal to navigation in 1855 the original State locks were operated 34 years, the Weitzel lock has been operated 30 years, the Poe lock has been operated 15 years, the Canadian lock has been operated 16 years; total, 95 years.

During this period the net registered tonnage has amounted to upwards of 600,000,000 tons, with only one accident resulting in the release of water from the summit level. This remarkable result is believed to be due mainly to the facilities afforded by the long approach walls in bringing ships under control.

Your general reporter has endeavored to summarize the opinions expressed by the several authors in the following conclusions:

(1) Standard dimensions applying to canals for heavy traffic, permitting interchange of traffic without transhipment, are desirable in any given country, and for adjacent countries where traffic is international to a great extent.

(2) Assuming suitable ports and facilities for handling freight in all cases as essential for economical transportation, the most suitable dimensions for canals will still depend upon many conditions, and particularly upon the general topography of the country, the nature of the principal items of freight to be transported, and the extent of inter-communication practicable. Such items as grain, ores and coal, loaded quickly with machinery at a single point and unloaded with like devices at another, favor the use of large boats, while smaller ones may be better adapted for general merchandise.

(3) Where extensive and well co-ordinated canal systems already exist it may be inadvisable to change, even if larger dimensions would be better adapted to the traffic.

(4) These various conditions have led to the adoption for canals in Germany and Italy of dimensions suitable for boats carrying about 600 tons and to the retention in France of dimensions suitable for boats carrying about 300 tons, except in some special cases; in other countries still larger dimensions have been adopted in part.

(5) It is not practicable, however, in every country, to establish standard dimensions. The traffic in certain districts may be so different in character and volume from that in other districts as to require special accommodation. Where interchange of traffic is impracticable uniformity in canal dimensions is of less importance.

(6) The question whether canals shall be free from tolls, or what proportion of the general costs of furnishing and maintaining the waterway shall be borne by the State is governed by the policy of the State.

(7) The organization of responsible transportation companies for canals which form links in trade routes, under suitable control by the State, should be encouraged.

(8) Movement of boats by power is desirable in canals with heavy traffic, and is necessary if the boats are large. Where boats are towed in trains by tugs or from the tow-path by electric tractors, the organization of monopolies for haulage, operating under State control, would be advantageous.

(9) Increased traffic capacity of the locks of canal systems can be obtained advantageously by adapting them for locking two or more boats at one time.

(10) The dimensions to be given locks of short canals flanking rapids in rivers will depend on the widely varying character of the traffic, the water supply usually being ample. Where the prevailing traffic is in barges of moderate size, moving in large fleets, as on the Ohio River, it is desirable to have dimensions sufficient to pass a considerable number of boats at one lockage. Each case must be studied by itself and no general rule can be laid down.

(11) For a heavy traffic the equipment of locks for operation by power is desirable. The equipment should be as simple as compatible with effective and safe operation.

(12) In certain cases, as where the level above the lock is connected with a large body of water, or where the unrestricted flow from the upper level would be disastrous to the canal works or to adjacent property, means should be provided for quickly stopping the flow.

3d Question: Intermediate and Terminal Ports—Best Methods for Combining, Facilitating and Harmonizing the Transfer of Freight between the Waterway and the Railway

General Report by Emory R. Johnson,* Ph. D.

The third question docketed for consideration by the First Section of the Twelfth International Navigation Congress is "Intermediate and Terminal Ports; Best Methods for Combining, Facilitating and Harmonizing the Transfer of Freight Between Waterways and Railways."

The ports to be included under the term "Intermediate and Terminal" are indicated by the following official definition phrased by the executive committee of the Permanent International Association of Navigation Congresses:

"The ports to be considered should be inland ports situated along the exclusively fluvial sections of rivers, along canals for inland navigation and along lakes.

"'Intermediate' ports may be established along these navigable highways if the traffic by water does not all end at the ports, but passes in both directions, as is the case with the port of Nancy.

"'Terminal' ports, on the contrary, are those which control the whole or very much the larger part of the traffic and prevent entirely, or very nearly so, any transportation by water beyond these ports.

"In Belgium, the 'terminal' port of Louvain, at the end of the canal from Louvain to the Rupel, may be mentioned, as may also the port of Leopoldville in the Belgian Congo, at the end of Stanley Pool, where the river navigation of the upper Congo ends.

"The port of Mannheim on the Rhine may be considered, however, as a terminal point, because of the enormous traffic which exists there as compared with the ports of Rheinau and Carlsruhe, which lie further up-stream. Frankfort is in like manner the 'terminal' port of the Main."

This definition of terminal ports excludes such harbors as those of New Orleans and New York, which are the termini of important inland waterways, but which are primarily ocean ports. However, among the papers prepared by the reporters upon the third question of the First Section are three relating to the city of New York. The papers upon New York harbor are of illustrative value, although they deal with ports excluded by the foregoing definition from consideration.

The following contributors have prepared papers that have been referred to the general reporter for review:

No. 22. Herr Stadtbaudirektor Eisenlohr, Strassburg, Germany.
No. 24. M. P. Mallet, Engineer of Arts and Manufactures, Member of the Chamber of Commerce, Paris, France.

* Professor of Transportation and Commerce, University of Pennsylvania, Philadelphia.

No. 27. Mr. M. Tsionglinsky, Engineer of Lines of Communication, St. Petersburg, Russia.
No. 23. Mr. Calvin Tomkins, Commissioner of Docks, New York, N. Y.
No. 25. Mr. Charles W. Staniford, Chief Engineer, Department of Docks and Ferries, New York, N. Y.
No. 26. Mr. S. Willet Hoag, Jr., Deputy Chief Engineer, Department of Docks and Ferries, New York.

From these papers the general reporter reaches the following conclusions:

1. The problem of combining, facilitating and harmonizing the transfer of freight between waterways and railways is partly administrative or governmental and partly technical or mechanical. The methods to be followed in dealing with questions of administration must depend upon whether the railroads are owned and operated by the government or by corporations.

In countries having State railroads the connection and co-ordination of railroads and waterways at ports can be readily accomplished by the co-operation of local and State governments. The necessity for such co-operation is generally recognized, and the requisite distribution between the municipality and the State of financial and administrative burdens is ordinarily made without serious difficulty.

The co-ordination of private railroads with public waterways being generally opposed by the railroad companies, must be, and ought to be, secured by the effective regulation of railroad services by National, State and local governments. The legislative and administrative requirements of the several political authorities should so supplement each other as to make a unified transportation system of the railroads and waterways in each country.

2. Whether terminal and intermediate ports are developed by private interests or by the municipalities, it is essential that each port should be systematically organized for the accommodation of the traffic and the industries to be served. In some instances this has been brought about by public regulation of ports owned and developed solely by private capital; but experience conclusively shows the need of supplementing public regulation of privately-developed terminals with the municipal ownership and operation of wharves, docks, warehouses and other harbor facilities for the general use of the public. The number and variety of wharves and other facilities that should be maintained by the State or municipality at any particular port will depend upon the local requirements of the port. Exclusive private ownership of water terminals is indefensible.

3. The actual legislative and administrative measure to be taken to co-ordinate railroads and waterways, to unify and systematize port facilities and to provide an efficient harbor administration must vary with different countries.

In the United States and countries having similar political organization it is necessary

(*a*) That the Federal Government, which has authority over inter-State commerce and carriers, should require railroad companies engaged in inter-State commerce:

1. To make physical connections with the waterways.
2. To exchange traffic with the waterways.
3. To issue through bills of lading and quote through rates over combined rail and water routes.
4. To secure to shippers the option of dispatching freight by an all-rail or by a rail-and-water line, when a choice of routes is possible.

(*b*) That the several State governments should take similar action concerning intra-State commerce and railroads.

(*c*) That each State should create in connection with the city government of each port a harbor department or board, and should authorize the municipality, acting through this department or board, to take such measures as may be necessary to unify and systematize the physical layout of the water terminal, to construct and operate such public quays, wharves, docks, warehouses and other harbor facilities as may be needed, and, generally, to regulate and develop the port.

4. In countries that do not have a federal government the State and local governments should co-operate (each country according to methods that have been found by experience to be wise and effective) to co-ordinate railroads and waterways to systematize and develop the ports, and to insure their use by the general public without unnecessary restriction or unfair discrimination.

5. The physical layout of intermediate and terminal ports and the mechanical appliances best adapted to the handling of traffic must be determined for each port separately and in accordance with its special requirements. Local, city and State engineers must apply to the solution of local problems, and adapt to local conditions the principles of port organization and operation that have been found effective at other ports and in other countries.

1st Communication: The Application of Reinforced Concrete to Hydraulic Works

GENERAL REPORT BY JOHN STEPHEN SEWELL*

The communications on this subject are as follows:

No. 31. By M. Jacquinot, Chief Engineer of the Ponts et Chaussées, Chaumont (Haute-Marne), France.
No. 32. By R. W. Vawdrey, A.M.I.CE., Portscatho, Parkhill Road, Sidcup, England.
No. 33. By the Hungarian State Water Survey.
No. 34. M. Mederico Perilli, Chief Engineer of the Genio Civile, Ravenna, Italy.
No. 30. By Mr. Richard L. Humphrey, President, National Association of Cement Users, United States of America.
No. 29. By Herr Regierungs and Baurat Schnapp, Berlin, Germany.
No. 35. By M. Alexander Nikolski, Chief Engineer of Lines of Communication, St. Petersburg, Russia.

The objections that have been raised against the use of reinforced concrete for the purpose under discussion relate to the durability of the concrete itself, to its resistance to abrasion, chemical action and freezing in contact with water, and to the durability of the reinforcement under various conditions.

Durability of Concrete

A few years ago difficulty was sometimes experienced in securing a Portland cement that was sound and secure against disintegration due to chemical changes within itself after setting. This difficulty is now easily avoided, and if aggregates are selected of durable and inert materials there can no longer be any doubt that concrete is in itself a thoroughly durable material, quite secure against disintegration due to action originating within the mass itself.

Resistance to Abrasion

Concrete as a rule exhibits more chipping and chafing under impact and abrasion than masonry of the harder stones. But this damage is usually only superficial, and rarely threatens the integrity or continued usefulness of the structure. In many cases it is more resistant than any other form of masonry available within practicable cost limits; the best of masonry is liable to be disfigured under impact and chafing, and there is very little of it in existence subject to these conditions that does not show the wear and tear. In any case, the trouble can be avoided at moderate expense, by means of strips of steel or timbers applied in the proper manner. This objection to concrete is therefore not a valid one, for it can be removed by simple and practicable methods.

Resistance to Chemical Action

Under this head may be included atmospheric agencies, the action of sea water, of sewage and of acidulated water. So far as atmospheric agencies are concerned, there is too much

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concrete which has successfully withstood them to leave any room for discussion. It is merely a question of good materials and workmanship, including proper mixtures to secure a dense and impervious mass.

A great many concrete structures exposed to sea water have suffered from extensive and rapid disintegration. It was at first supposed that this was due to the action of the sea water on some constituent of the cement, probably the free lime. Some experiments and investigations have seemed to indicate that the addition of trass or pozzuolana to the cement would prevent this action by satisfying the free lime. But it also appears probable that, as Mr. Humphrey states, a dense, strong and impervious mixture allowed to harden before exposure in place is in itself sufficiently resistant, whether the preliminary disintegration has been due to freezing when saturated with water or whether it is due entirely to chemical action. The requisite density and strength can best be obtained with a well balanced and rather wet mixture. The conclusion seems justified that exposure to sea water is not necessarily fatal to the use of concrete.

Navigation canals may carry domestic sewage, factory waste and acidulated water from mines, since all of these ingredients are to be found in the waters of streams from which canals are fed. So far as navigation works are concerned, the deleterious ingredients will generally be so diluted that their action will be very slow, and probably the same precautions that suffice in the case of sea water will serve the purpose here also. Should cases arise where the deleterious ingredients exist in greater proportion, it is probable that any kind of masonry would suffer more or less by action upon the cement in the joints, if in no other way; but there are many methods of waterproofing masonry, any one of which ought to protect the concrete from contact with acidulated water or sewage, and therefore from damage. It appears, therefore, that even the existence of these agencies need not be a fatal objection to the use of concrete, for their activities can be prevented at practicable cost; only in extreme cases would such protection be required in navigation works, and even then the protected concrete may easily be the least expensive material available.

Freezing in Contact with Water

Resistance to damage from this cause seems to be merely a question of density and strength. The same thing is true of stone and bricks. That concrete can be made sufficiently impervious and strong is demonstrated by many examples. Here, again, a well balanced wet mixture, protected from washing out of the cement during the hardening process, is all that is required.

Durability of Reinforcement

It is no longer open to serious doubt that steel or iron thoroughly embedded in Portland cement concrete will last indefinitely, as long as the covering remains intact. If it is exposed directly to the air, whether near the sea or not, it will inevitably corrode and ultimately destroy the structure. Careful design and good workmanship are all that are required to properly imbed it, in the first place. The only danger that threatens it thereafter is the danger of cracks, which will destroy the integrity of the concrete and open up a way for atmospheric moisture or water to gain direct access to the reinforcement. Such cracks might be due to shrinkage in setting, to expansion and contraction under changes of temperature, or to deformation under stress. If the concrete is mixed wet, and kept wet while setting, there is small danger of shrinkage cracks. Cracks due to expansion and contraction after setting are brought about probably by a slight slipping of the mass on its bed during expansion, and by the excess of frictional resistance over the tensile strength of the concrete during the subsequent contraction. This trouble can be overcome by proper reinforcement, but it would be well to divide a long wall or other structure into sections, so that each could act as a unit. Cracks due to deformation under stress will occur only when the reinforcement is stressed so that the strain exceeds the limit of extensibility of the concrete. This can be avoided by proper design and workmanship. If working stresses are kept well within the limits allowable for mild steel there is no danger of cracks in the concrete. It appears, therefore, that it is entirely possible to maintain the integrity of the concrete coating and therefore to prevent corrosion of the reinforcement, and there is no valid objection in this score.

Mr. Humphrey refers to the corrosion of reinforcement exposed near the sea. It is also a fact that if the concrete is mixed with sea water, or with sand from the sea beaches, or if it has salt mixed with it, and it is subsequently exposed to dampness, the reinforcement will corrode. It is of importance, therefore, that the ingredients used in mixing concrete for hydraulic works should contain no corrosive material in themselves if the concrete is to be reinforced.

The conclusion seems justified that all of the objections that have been urged against the use of reinforced concrete as a material suitable for use in connection with hydraulic works are either imaginary or can be overcome by practicable methods, and must have arisen at a time when the subject was not so well understood as at present. That this conclusion is justified is abundantly proven by the increasing and successful use of the material in permanent structures everywhere, as indicated by the papers herein reviewed.

The great advantage of reinforced concrete lies in the fact that it is capable of withstanding stresses due to transverse strains, tension and shearing. All the forms that could be executed in steel or timber can be closely imitated in reinforced concrete, which is immune from corrosion and decay. This makes it possible to adopt designs wherein the structure acts by its structural resistance and not by dead weight, and even the material to be retained and held back may be made, by this means, to add to the stability of the work as a whole. Dead weights on foundations are diminished, difficult excavation is often avoided or lessened, and total costs often greatly decreased, as compared with structures formed of masonry in mass; in many cases reinforced concrete affords the only practicable solution of a difficult problem, and in nearly all cases it affords a variety of desirable solutions not practicable in any other material.

The saving in thickness of inverts of locks and dams, of retaining walls of all kinds, the use of caissons filled with dead materials in lieu of solid masonry walls, the use of reinforced concrete piles to anchor a light structure to the dead mass below, and the many other useful devices and applications either described or suggested in the papers on this subject, all open up the possibility of practically limitless applications of reinforced concrete to hydraulic structures so as to attain both greater efficiency and a diminished cost.

A study of the successful applications of reinforced concrete submitted to the Congress by the various reporters appears to justify the adoption of the following conclusions:

Reinforced concrete combines the structural qualties of steel and timber with the durability of good masonry. It is subject to no form of deterioration which cannot be avoided by reasonable precautions. It is free from many of the limitations surrounding the use of masonry in mass; because of the greater latitude it affords in the design and execution of structures, it often yields the best and most economical solution, and in some cases the only practicable solution, of the most difficult problems. When properly designed and executed it is, therefore, among the most valuable, if not the most valuable, material now available for use in connection with hydraulic works of all kinds.

2d Communication: Report on the Works Undertaken and the Measures Adopted or Proposed for the Improvement and Development of Lines of Inland Navigation, as well as for the Protection of the Banks of Navigable Highways

GENERAL REPORT BY HENRY C. NEWCOMER*

Ten reports have been submitted on this subject as follows:

No. 37. Herr Regierungs and Baurat Bergius, in Oderberg (Mark.)
No. 38. Mr. E. J. Marote, Chief Engineer, Director of the Ponts et Chaussées, Brussels, and Mr. Jules Descans, Principal Engineer of the Ponts et Chaussées, Antwerp.
No. 39. Major William D. Connor, Corps of Engineers, United States Army, Member of the American Society of Civil Engineers.
No. 40. Mr. L. Dusuzeau, Chief Engineer of the Ponts et Chaussées, Professor at the National School of the Ponts et Chaussées, Compiegne (Oise).
No. 41. Mr. J. A. Saner, M. I. C. E., Chief Engineer of the Weaver Navigation, Northwich.
No. 42. Mr. Antonio Castiglione, President, and Mr. Mario Beretta, Secretary of the Committee for Inland Navigation, Milan.
No. 43. Mr. A. R. Van Loon, Engineer of the Waterstaat, Bois-le-Duc.
No. 44. Mr. E. A. Wodarski, Engineer of Lines of Communication, St. Petersburg.
No. 44*bis*. Mr. Emile de Hoerschelmann, Councillor of State, Member of the Council of Engineers at the Ministry of Lines of Communication, Tsarskoie-Selo (near St. Petersburg).
No. 45. Captain G. Malm, of the Royal Corps of Bridges and Roads, Chief Engineer of Works of Construction of the Royal Administration of Hydraulic Motive Powers of Sweden, Stockholm.

Two of the reports, Nos. 39 and 44, cover in a comprehensive way the general waterway situation, while the rest have been devoted mainly to certain features, to recent improvements in design, plans for new work, or measures proposed for the further development or improvement of navigation facilities.

R. Bergius gives some recent improvements in canal construction in Germany, including a flight of four locks and a safety gate on the Berlin-Stettin waterway, a new arrangement of inverted siphon culverts under the Datteln-Hamm Canal, and several forms of canal bank protection.

E. J. Marote and J. Descans describe the principal waterways of Belgium and the further improvements that are contemplated. In each case, however, the main attention is devoted to the forms of bank protection in use.

The authors conclude that

"1. In the canals where the navigation traffic is not intense, where the draft of the boats is low and where the circulation of screw-propelled boats is nil, the slopes are generally protected by plantation of osiers, or reeds or alders on the berms placed several centimeters below the water level. As the traffic develops the necessity of a more efficacious protection makes itself felt, and recourse is had to simple or double puddling

"2. When steam or motor traction is used, the erosions, due to current or wash which the boats cause, soon occur in mobile soils. This is generally remedied by the construction about the center of the water level of a skirting supported on piles and surmounted either by turfing or by protection in hard materials either in masonry work or not. When the local circumstances allow of the lowering of the water during more or less long periods, stonework in masonry or dry is preferred, founded on a berm generally one meter below water and sometimes supported by a framework of piles and skirting.

"3. When the navigation of screw-propelled boats is great and when the lowering of the water level is not admissible the consolidation of the banks is obtained either by the 'Villa' system or by the driving down of a row of piles and of a sheet-piling frontage surmounted by a covering of hard material above the water level.

"4. At the Congress of Vienna the relation between the immersed cross-section of a boat and the wetted cross-section of a canal has been fixed at one-fourth, in the supposition that the speeds of the boats would not be greater than 6 kilometers per hour.

"5. The only means of protecting effectually the concave banks seems to consist in the covering of them with natural or artificial stones in masonry or dry, supported on a simple berm either on stone pitching or on a framework consisting of piles with skirting of sheet piling.

"6. In the interest of navigation and with a view to suppress stoppages to navigation, or at least to reduce their duration, the method of bank protection should be designed in such a manner as to permit their maintenance without lowering the water level either under cover of sheeting or easily removable and fixed cofferdam."

W. D. Connor gives a general account of the inland waterways of the United States and of the types of works used in their improvement.

L. Dusuzeau's is devoted to a brief discussion of the measures adopted or proposed in France for the suppression of general and periodical stoppages of traffic to make repairs, and for the methodical organization of waterway transportation. The measures proposed are as follows:

A. "General stoppages must be abolished—at any rate on much frequented navigable waterways.

"Such waterways should be made fit to undergo this new regime, for which purpose the following measures should be taken:

"1. Put the under-water masonry into perfect order.

"2. Choose a type of slope protection such as can be installed and maintained by means of movable dams of simple construction and at low cost.

3. Adopt a design of rigid iron lock gates without any woodwork about them, as wood continually requires repairs; prefer a means of closing sluices and gates which does not involve the use of delicate parts under water; such as the gate with a vertical heel post, and especially the balanced lifting gate.

"4. For weirs in canalized rivers, give up those with needles which lie down on the floor and which floods and floating ice damage every year, and have recourse to great balanced sluices generally worked by steam or electricity, which can also, if the need arise, be worked by hand.

"5. Make provision in the inverts and the lock heads for appliances to which cofferdams can be easily fitted so as to get at some part or the whole of these works without lowering the water in the reaches.

B. "1. The installation on navigable waterways having an average traffic of over twenty barges a day, of haulage services monopolized by the State itself or under contract from it, with fixed charges, in connection with, and having similar rates to, the various systems in each State and in the neighboring ones.

"2. The appointment of special establishments which would form a link between the shippers, the consignees and the boatmen.

"3. Unification, in neighboring States, of the general principles governing police conservancy regulations on navigable waterways and the laws applicable to demurrage charges on inland navigation."

The report by Antonio Castiglione and Mario Beretta is devoted to an explanation of the Bertolini law concerning inland waterways in Italy, after stating the circumstances leading up to its enactment. It is the outcome of an agitation for improved navigation that has been in progress for about ten years. The State has had control of navigable waterways, but they were allowed to deteriorate, and many proposals were made calling for the restoration of old channels and the provision of new ones. The principles governing the apportionment of necessary expenditures, as well as the determination of a programme of procedure, were finally settled, after much discussion, by the passage of the Bertolini law in January, 1910.

A. E. Wodarski attaches great value to dredging as a means of improvement for Russian rivers; he also gives instances of

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successful regulation, and he considers this method essential on some streams and canalization on others, especially in cases where considerable increase in depth is sought.

3d Communication: Utilization of the Navigation of Large but Shallow Rivers—Vessels and Motors

GENERAL REPORT BY LANSING H. BEACH*

Four papers have been presented on this subject as follows:

47. A comparison of the relative economies of a side wheel and a propeller-in-tunnel towboat, by Herr Director R. Blumcke of Mannheim.
48. Reasons for the decadence of traffic on the Mississippi River, by C. McD. Townsend, Colonel, Corps of Engineers, U. S. Army.
49. The tunnel towboat as used on the Trent, by F. Rayner, General Manager of the Trent Navigation Co., Nottingham.
51. Statement concerning motor boats on Russian rivers, by H. Merczyng, Professor at the Institute of Engineers of Lines of Communication, St. Petersburg.

In the report by Herr R. Blümke it is stated that owing to the building facilities afforded by the Dutch ship-mortgage banks, the Rhine has suffered from an over-supply of barges, and it has become the earnest endeavor of German shipbuilders to provide a light draft towboat which shall be powerful and still relatively cheap. As the result of their studies in this direction the Schiffs-Maschinenbau A. G., of Mannheim, produced the twin-screw tunnel steamer *Gebr. Page X*, this boat being a development from numerous smaller tunnel steamers built by the same company. In order to finally determine the relative efficiency of the tunnel and side-wheel types of towboats, comparative runs were made upon the upper Rhine with the *Gebr. Page X* and the *Bavaria*, a side-wheel boat of about the same power. The conclusion is drawn from these trials that the tunnel boat is at least the economical equal of the side-wheel steamer, and the further advantages of low first cost, minimum width for use in narrow rivers and canals and reduced cost of maintenance are cited. The data includes the relative costs of producing 1 pound of towrope pull at 7.8 miles per hour with the two types, and also the cost per ton-mile of freight carried by these two types of boats. From these results the foregoing conclusion is drawn.

The most important conclusions reached in Mr. Townsend's report are:

1. That the problem of the "Utilization of the Navigation of Large but Shallow Rivers" differs in different countries and is a function of the extent and efficiency of their railroad systems.

2. To obtain supremacy for river navigation it is necessary to utilize the towboat and barge method rather than the freight-carrying steamboat.

3. With this method and a 9-foot channel as great economies of transportation may be obtained as on the Great Lakes, and with a 6-foot channel greater than at present obtain on railroads if equal terminal facilities are provided.

4. A revolution in the means of propulsion by the introduction of electricity or liquid fuel will not revive river commerce where the railroad can utilize the invention as cheaply as the boat, although the motor boat for subsidiary lines will reduce the cost per ton mile owing to the small crew required.

5. The utilization of the navigation of large but shallow rivers is a factor of the density of traffic and of population.

The tunnel type of towboat, as used on the Trent, is described by F. Rayner, and the author reaches the conclusion that the hinged flap in a tunnel will yield an increase of speed of 1 knot beyond that obtained by a boat of the same dimensions and power when equipped with the usual type of tunnel.

Conditions on Russian rivers are reviewed by Prof. H. Merczyng, and the statement is made that Russian designers have been forced to the saving of weight by the adoption of the internal-combustion engine. The construction of boats in detachable sections is advocated in order to provide means of reducing draft by the addition of one or more sections.

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IId Section: Ocean Navigation

1st Question: Means for Docking and Repairing Vessels

GENERAL REPORT BY MORDECAI T. ENDICOTT*

According to the reports upon the above question there are three things of especial importance dwelt upon therein, viz.: First, the methods and details of construction of docks for taking up seagoing vessels, which contain many actual experiences with valuable lessons for the information and guidance of those who construct and use them. Second, the great value to a port and its shipping of ample establishments for docking and repairing vessels, and the failure to keep pace, in this respect, with the constantly-increasing size of vessels, both for the merchant and naval marines. These papers contain a forecast of vessels of an ultimate length of 1,300 feet and breadth of 135 feet, and it does not seem unreasonable to look forward to these dimensions, and to provide docking facilities which shall be able to receive and repair them. Third, the types of dock suited to the docking and repairing of vessels. This last is a question which has engaged the earnest attention of previous Congresses. In the present reports it is, without exception, treated more or less fully, and opinions differ considerably. Two of the writers express opinions in favor of the floating dock, under practically all circumstances; four regard the graving dock as superior for nearly all docking work, and three express no special preference for either. Substantially all the writers refer to local conditions as affecting the practicability or advisability of establishing one or the other type, and some have left the subject with the remark that the type to be used must be determined by local conditions, without giving an opinion as to which type, other things being equal, is to be preferred.

There can be no doubt that the decision as to the type of dock to be used in any locality must be made after a careful consideration of the conditions existing there; there may be some feature in the situation which would preclude the establishment or use of one or the other type; there may be conditions affecting the cost to so great extent as to settle the matter upon this basis alone, but there is in the minds of most engineers and naval experts a definite opinion as to the value and desirability of the two types where practicable to establish them, and the writer is of the opinion that this is the decision, if any, to which the Congress should give expression. Which type, when practicable to be installed, best meets the demands of commerce for the safe and economical docking and repairs of seagoing vessels? It is believed that the Congress could reach a decision upon this point, and it is such a decision as would be of value to the world, and for which, perhaps, it has some reason to look.

The preponderance of opinion, in the reports reviewed, is in favor of the graving dock. A study of all these reports, both pro and con, serves to confirm the opinion of the general reporter, formed after an observation and experience extending over a long term of years, that graving docks supply in the greatest degree the conditions of safety, convenience and economy for the docking and repairs of seagoing vessels.

2d Question: Dimensions to be Given to Maritime Canals—Technical Point of View—Probable Dimensions of the Sea-Going Vessels of the Future

GENERAL REPORT BY C. E. GRUNSKY,† Dr. Eng.

There have been six papers submitted to the general reporter on the above question. These are as follows:

No. 63. By G. de Thierry, Baurat, Professor an der Königl. Technischen Hochschule Charlottenburg, Mitglied der Internationalen Technischen Commission des Suez Kanals, Berlin-Halensee, Germany.
No. 64. By H. Vander Vin, Ingénieur en chef Directeur des Ponts et Chaussées, Antwerp, Belgium.

* Rear Admiral, U. S. N., Retired, Washington, D. C.
† San Francisco, Cal.

No. 65. By Dr. S. E. L. Corthell, Civil Engineer, New York, United States.
No. 67. By J. Foster King, Chief Surveyor to the British Corporation for the Registry of Shipping, Glasgow, Great Britain.
No. 68. C. Leemans, Civil Engineer, Amsterdam, Holland.
No. 69. By E. I. Zamjatin, Naval Engineer, St. Petersburg, Russia.

This question is understood by the general reporter to relate specifically to the minimum dimensions of the canals and to the dimensions of the large seagoing vessels. The interrelation of the size of the largest seagoing vessels and of the required dimensions of the canals is recognized in the question.

If it be admitted that the dimensions of the seagoing vessels are to be determined solely by the needs of trade and commerce, by economy of operation, and by the demands of passengers for speed, comfort and luxuries, without regard to harbor facilities and without regard to the possible usefulness of the vessels to their governments in case of war, then it becomes comparatively easy to predict future growth. As Dr. Corthell contends, the law would really be inexorable,and no one could foresee a limit to the size of the largest vessel.

But, and perhaps fortunately, there are other considerations to be taken into account, notably the general usefulness of large vessels, which, according to their size and particularly their draft, may be materially restricted by the dimensions of maritime canals and the depth of the approaches to the principal harbors of the world. To this point particular attention is asked, and the Twelfth International Navigation Congress may well consider whether or not it is desirable to point out other means of restricting the rate of increase in the size of vessels than only by the demands of the shipowners and the ability of the shipbuilders to comply with these demands.

It appears from all of the papers which have been submitted that there is no check yet apparent to the rate at which the dimensions of the largest seagoing vessels are increasing. The vessel of over 50,000 tons is being built, and those who should know expect the vessel of 70,000 tons or more to put in her appearance soon.

Would this be possible without government aid? Some of the transatlantic steamship companies are so heavily subsidized that their ships are practically in government ownership. On the Pacific, too, the economic success of transportation in large vessels is made possible by subsidies in one form or another. Our own country, which does not subsidize, is out of the running. It has no merchant marine to speak of. In other words, the operation of large steamers without subsidy is not profitable, at any rate not in competition with subsidized vessels.

And yet, if commerce between nations had been developed without government aid, and if the commerce on the high seas nad been and were carried on only by vessels of moderate size, there would have been a suitable adjustment to such conditions, and there would be little if any less volume of business between nations than is found to-day.

Perhaps, upon careful analysis, it may, even under established conditions, be found preferable to operate ten steamers of 10,000 tons each, rather than only two of 50,000 tons. From the standpoint of the government of any maritime country it would certainly be more desirable to have at its disposal when needed ten ships of 10,000 tons than two of 50,000 tons.

Having given consideration to the views of the experts as presented in these papers, the general reporter adds that no evidence has been found by him and none is presented in the papers which would indicate that for the present any other consideration than the demands of commerce and the willingness of the traveling public to pay for room, comfort and luxuries, and the ability of the shipbuilders to build the ships will set a limit to the size of the ocean liner. In other words, if the deepening of the harbors and of harbor approaches is continued without restriction the size of the largest ocean liners will, under otherwise permanent conditions, continue to increase.

Without any restrictions upon the size of vessels they will be built constantly larger as demanded by economy of operation and by the needs of commerce, and only those ports can hope to be favored with the visits of the largest vessels which find it worth while to afford suitable harbor facilities.

The growth of vessels, therefore, exerts a strong influence upon the concentration of the export and import business at certain points, such as New York harbor, where nature has made possible the construction of the facilities demanded by the shipowner who wants to operate the largest boats that can with safety and without delay be taken into and out of the best harbors on the two sides of the Atlantic.

It follows from this that it is to the interest of the port which is less favored by natural conditions that some artificial limit be set to the size of the ocean carriers, particularly in the matter of draft, in order that harbor improvements may be planned with reasonable certainty that they will be adequate.

There should be an international agreement entered into that some depth of water at low tide is the standard to which the important harbors of the world should be improved, and there should be no government aid in the form of subsidy or otherwise to vessels whose dimensions are such as to make the entrance into a harbor of standard depth impossible.

It would be unwise, for example, for the United States to construct or to encourage by subvention or otherwise the construction of vessels too large to pass through the locks of the Panama Canal.

The usefulness to the government in time of war of a vessel depends upon its adaptability to the momentary requirements. It should be large enough, and yet not of such colossal dimensions that it cannot make port at some unforeseen new destination.

By the construction of the Panama Canal, a stupendous undertaking, the United States has practically set an upper limit for the dimensions of vessels whose construction can be encouraged by the Government. The canal and the lock system on the canal have cost too much to be readily modified. For the time being the usable lock length on this canal of 1,000 feet, the breadth of 110 feet and the depth of 41.5 feet on the sills of the lock gates, equal to 40 feet in salt water, or to 12.2 meters, has fixed the maximum dimensions both of war vessels and other vessels that are likely to be constructed by the United States or by American owners under the stimulus of Government aid.

But if the standard maximum dimensions for the largest desirable seagoing vessels be thus set by the United States, or by an international agreement participated in by the important maritime nations, this will not set a limit to the further improvement of shipping. There is room for improvement even when the limit of size has been reached. The internal combustion engine, for example, is full of promise, and may, as forecasted by Mr. Zamjatin, be of material aid in increasing cargo capacity. The gain in cargo capacity resulting in the use of internal-combustion engines would, moreover, be of particular value, because it is obtained without an increase in displacement. So, too, in the matter of speed there need be no limit set, unless for subsidized vessels it be a lower limit. If the reduction of weight of machinery and of fuel in the motor boat compared with the steamboat even approaches the figures given by Mr. Zamjatin, there should be ample opportunity for securing high speed without being compelled to give the vessels abnormal dimensions.

It remains to be stated that the largest vessels on such special routes as the one between New York and European ports stand apart in a class by themselves, and their dimensions need not be taken into account in forecasting the dimensions of the vessels for whose use the great maritime canals such as the Suez Canal and the Panama Canal and other canals of the first rank are constructed.

The following conclusions appear to be justified and are recommended for adoption by the Congress:

1. It is desirable that a limit be set to the draft of seagoing vessels.

2. Government aid should not be extended to the building or operation of seagoing vessels whose draft exceed 32.2 feet.

3. There should be an international agreement fixing the maximum dimensions of seagoing vessels built or operated under Government subvention, and there are tentatively suggested the following:

Length over all, 900 feet.

Breadth, 105 feet.

Draft, 32.2 feet.

4. Any maritime canal which has locks with a usable length of 1,000 feet, a width of 110 feet, and a depth of water on the sill of 35 feet will fulfill every reasonable requirement of commerce.

5. In a maritime canal a wet section five times as large as the immersed portion of the largest ship which is to use the canal is desirable, as also a depth of 1 meter under the keel; but these values are functions of the speed at which the canal is to be navigated, and therefore to some extent also of the volume of commerce, and are to be determined by local conditions.

3d Question: Mechanical Equipment of Ports

GENERAL REPORT BY JOHN A. BENSEL*

Seven reports on the Mechanical Equipment of Ports have been submitted. Five of the reporters have confined themselves to the mechanical equipment for the loading and unloading of vessels. Mr. Barling has gone briefly into the mechanical equipment for the operation of drydocks, wet docks and tidal basins, and Messrs. Wouter, Cool and de Kanter have briefly described floating docks for the repair of vessels and a steam ferry for the transportation of railroad cars.

The mechanical equipment for loading and unloading vessels may be divided into that used for general cargo or package freight and that for bulk materials, such as grain, coal and ore.

Machinery for Handling General Cargo

In Europe ships are usually moored to quays or dock walls having solid foundations on which are located sheds or warehouses with railroad tracks on both sides. Quay cranes have been in use for nearly four centuries operated by man-power and by steam, hydraulic and electric motors. There has been an enormous increase in such cranes during the past ten years. Many are owned by municipalities, which accounts for their installations in places where they may not directly pay a direct profit sufficient to cover the cost of interest and depreciation and operation. Many of these cranes do not work more than from 1,000 to 1,500 hours in a year.

Hydraulic cranes are still used in old installations, and in England are preferred to electric cranes, but in most places new installations are electrically operated wherever current can be obtained from a central power station.

The general type is that of a traveling gantry spanning one or more railroad tracks, carrying on top of it a revolving jib crane. One leg of the gantry runs on a rail on the edge of the quay and the other on another rail on the ground or on the roof of the freight shed. These are called portal or semi-portal cranes. Most of them are moved along the tracks by hand power, but some of them are traversed by power. Some have fixed jibs and some have movable jibs, which decrease the distance through which the load is transported, and which obviate the necessity of removing shrouds, stays and other rigging from the vessels. In some places the entire crane is supported on the roof of the warehouse. The capacity of these cranes is from 30 cwt. to 3 tons.

Various types of cranes with grabs, buckets, wall cranes, lowering cranes where no load is to be hoisted and the crane hook is raised by a counterweight, wall cranes for loading cars from the warehouse and warehouse elevators and hoists, are also in use.

"Transporter" cranes of the traveling gantry type, with a hinged arm extending over the vessl's hatch while the load is transported in a straight line at right angles to the vessel, suspended from an overhead traveler, are also in use and are more efficient under certain conditions.

Floating cranes, usually steam operated, are much used, and they vary in capacity from 1½ to 100 tons or more.

One or more heavy-duty cranes up to 150 tons capacity are usually provided in each important port.

In the United States and Canada the mechanical equipment for handling general cargo has not reached the development that it has in Europe. Cranes or other devices provided by the municipalities are almost unheard of, and in most places the savings by machinery over the customary methods do not pay for the interest, maintenance and operating cost. Many of the wooden pile piers at which ships unload are not strong enough to carry heavy cranes. General cargo is usually handled by the ship's winches. The quay cranes in use in Europe are almost unknown. In this connection it should be noted that in Europe the "wagons" or freight cars are usually of the type known in America as "gondolas," without any roof, the merchandise being protected from the weather by covers of waterproof canvas. In America general merchandise is usually carried in "vans" or box-cars, which cannot be loaded directly by means of a crane. Other reasons why the cranes used so largely in Europe are not used in America are clearly set forth in Mr. Hodgdon's paper.

Hand trucks of a peculiar pattern are largely used to transport the freight from the point of unloading to the cars or storage space. In many places mechanical aids have been devised to assist in handling these trucks, such as elevating ramps and moving platforms.

Electric telpherage has been installed in some places. This apparatus consists of an electrically-driven car carrying a hoisting winch and the operator, suspended from wheels which run on a single overhead track. The goods are placed in skips, crates or slings for transportation from the unloading point to the point of deposit. The tracks are arranged in circuits so that the carriages do not go and return by the same route.

There are some installations of the "transporter-crane" type for handling freight from cars to barges and lighters.

A feature of freight handling in New York is the car float, by means of which eight to twenty-four railroad cars are brought alongside a wharf or vessel from the railroad terminal.

Floating cranes and derrick lighters having capacities from 20 to 100 tons are in use as in Europe, and there are some stationary cranes having capacities up to 150 tons.

Machinery for Handling Grain

Grain is handled by special installations, and machinery and the general principles do not vary very much in various parts of the world. Floating elevators of the bucket and pneumatic types are used for transferring grain from one vessel to another, or from the vessel to the "silos," storage bins or other places of deposit. Bucket elevator and conveyor or "transporter" belts are in general use for moving the material about on land. The operation is much simplified in America by the system by which identical ownership is dispensed with. All grain is graded as soon as received at the storage point, and all grain of the same quality is stored in the same bins, certificates of deposit showing quantity and quality being issued to the owner.

Machinery for Handling Coal

Coal-handling machinery may be divided into two classes—that for ships' bunker coal and that for cargo coal.

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In many ports in America as well as in Europe there are barges of 600 or 700 tons capacity fitted with bins having "hopper bottoms," from which the coal falls by gravity onto a conveyor, which carries it to a tower elevator and empties it by means of a chute directly into the ship's bunkers.

The machinery for handling cargo coal has its largest development in America. Car tipples, which dump a car of 100,000 pounds capacity at one time, are not infrequent. Similar machines are in use in Europe but are of less capacity. Traveling or "transporter" cranes are used in many places.

Machinery for Handling Ore and Minerals

The handling of ore and minerals has reached an extreme development on the Great Lakes of America, where by means of specially designed ships enormous elevated storage bins and huge grabs vessels carrying 10,000 tons can be unloaded and loaded within a few hours.

Special Machinery for Various Materials

Special installations have been described as follows: Fish, bananas, cotton, garden produce, passengers' luggage and phosphates.

1st Communication: High-Powered Dredgers and Means of Removing Rock Under Water

GENERAL REPORT BY W. L. SAUNDERS*

The reports upon this subject, eight in number, are from Mr. Michael Koch, of the Royal Hungarian Navigation Board in Orsova, Hungary; Mr. Vidal, Ingenieur en Chef des Ponts et Chaussées, Bordeaux, France; Mr. Ramon Hernandez, Ingenieur du Corps Espagnol des Routes, Canaux et Ports, Oviedo, Spain; Mr. N. K. Sundblad, engineer, chief assistant to the works of the Trollhättan Canal, Trollhättan, Sweden; Mr. Viovanni Fossataro, Ingegnere del Genio Civile, Venezia; Mr. R. Blumcke, director of the Shipbuilding & Machine Works Company, Ltd., Mannheim, Germany; Mr. Sidney B. Williamson, chief engineer Pacific Division, Isthmian Canal, Corozal, Canal Zone, Isthmus of Panama, and Messrs. A. de Kanter and H. C. Wesseling, engineers on the Works of Rotterdam, Holland.

These papers describe exhaustively and thoroughly the subject of high-powered dredgers and the means of removing rock under water; and the wide experience and ability of the authors, which has attained for them their pre-eminence amongst engineers, makes each report authoritative on the subject with which it deals.

During the last few years the design of dredging machines has undergone a marked change. This change has been towards increasing the output of the dredgers by the construction of dredgers of greater power and larger size. The tendency of these improvements is well illustrated in that great suction dredger built for use on the Mersey; this dredger (aptly named the *Leviathan*) has a rated capacity to excavate the enormous quantity of 10,000 cubic yards in 50 minutes. Other examples of radical improvement in design and efficiency are those dredgers built on the Frühling system, whereby the proportion of solids excavated has been so much increased in hydraulic dredgers. The elevator dredger recently built in Scotland for the Panama Canal, with buckets of 2 cubic yards capacity each, and the large dipper dredgers in America with buckets up to 15 cubic yards in capacity, are other examples of this trend towards increased size and capacity.

It is found from the standpoint of an investment, where the amount of material to be excavated justifies it, that the lessened cost per cubic yard excavated, due to the decrease in the cost of management, labor, fuel and maintenance, more than compensates for the great outlay necessary to construct these larger machines. The increasing use of cast steel has been a great factor in the improvement of dredgers. This is especially evident where manganese steel has replaced the softer steels in bucket mouths, pin connections and other parts exposed to great wear.

In the United States, until very recently, the elevator dredger has not been regarded with favor. It was generally regarded by our engineers as a machine adapted to soft material, and more costly to build and maintain than the suction, dipper or grab dredger.

The performance of elevator dredgers on the Panama Canal, which are rebuilt machines of the French régime, has gone far to establish, through their economy of output, their many advantages, as is evidenced by the purchase of a large machine of this type in Scotland for use on the canal.

In Canada the elevator type had been in favor and use even before the dipper dredger had been developed. It is now being recognized that in hard material, such as hard-pan and indurated clay, where the formation is not hard enough to justify the use of explosives under water, the elevator type is more efficient than the dipper type. This was demonstrated on the St. Lawrence River in excavating a water-power canal through indurated clay. In this instance dipper dredgers of the most powerful design failed, and were replaced by an elevator dredger which completed the excavation in a satisfactory manner.

The dipper dredger, on the other hand, has its advantages over the elevator type under many conditions, and under certain circumstances (as in the construction of canals) is complementary to it.

General Conclusions

The type or designs of dredger that may be employed is governed by the surrounding conditions in which it works.

Generally considered, where the scene of operation is open water and excavating light material, such as mud or sand, suction dredgers with a drag suction, or elevator dredgers, may be employed to the greatest advantage.

Where the situation is confined, as between and around docks and in narrow channels, the grab or clam-shell and the dipper dredger are better adapted for the purpose.

In classifying the types in accordance with their effectiveness in the different classes of material, it would appear that the Frühling system has developed the greatest efficiency in excavating mud and fine sand. This efficiency is due to the design and action of the suction head, which, it is stated, will under certain favorable conditions excavate a semi-fluid mass of a consistency from 80 to 90 percent solid. It is stated that the average cost, all charges included, over a full season's work, has reached the low point of nine-tenths of 1 cent per cubic yard.

In the clays, suction dredgers fitted with revolving cutter heads at the mouth of the suction pipe have proven most effective.

In hard clays the elevator and dipper dredgers give the best results.

The very hard indurated clays, shales, soft rock formations and hard-pans, are excavated most economically by elevator dredgers. This refers to dredging without previous blasting.

Rock that has been broken is most economically dredged by the elevator type or the dipper type of dredger. Where the rock is broken by breakers of the Lobnitz type, and where the depth of each breaking is limited to 2 or 3 feet, the elevator dredger, owing to its ability to dredge closer to a given grade, is more effective. Where rock is drilled and blasted, the rock being broken in large pieces and the depth of the cut or broken masses of rock more than 3 feet, the dipper dredger will demonstrate superior economy. This does not apply to excavations in depths of 35 feet or more, as the dipper

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dredgers, owing to their mechanical design, lose their effectiveness beyond certain depths.

From a great amount of data available it would appear that drilling and blasting by the American method is the most rapid and economical means of preparing the harder rocks for dredging where the depth of rock to be removed is greater than 2 feet in depth. When the rock to be removed is less than 2 feet in depth, the Lobnitz type of crusher attains greater economy as a means of breaking rock. This depth of 2 feet may be increased in thinly stratified rock or in rock that shatters easily.

2d Communication: Report on the Most Recent Works Constructed at the More Important Seaports and Especially on those Relating to Breakwaters—Applications of Reinforced Concrete—Means for Insuring its Preservation

GENERAL REPORT BY EDWARD BURR *

Upon the second communication, second section, Ocean Navigation, the reports before the Congress are ten in number, viz.:

1. The General Government of Algeria.
2. H. Mönch, Geheimer Oberbaurat und Vortragender Rat im Reichs-Marine-Amt, Berlin.
3. C. Bech, Engineer in the Royal Danish Waterworks Department, Chief Engineer to the Harbour Trust of Helsingör (Elsinore). N. C. Monberg, Civil Engineer and Undertaker, Copenhagen. H. C. V. Möller, Chief Engineer to the Harbour Trust of Copenhagen.
4. J. F. Hasskarl, Director, Department of Wharves, Docks and Ferries, Philadelphia, Pa.
5. J. Voisin, Ingénieur en Chef des Ponts et Chaussées, Boulogne-sur-Mer.
6. A. E. Carey, Member of the Institution of Civil Engineers, and Fellow of the Royal Geographical, Chemical and Geological Societies, London.
7. I. Inglese, Inspector-General of the Corps of Civil Engineers, Genoa. L. Luiggi, Inspector-General of the Corps of Civil Engineers and Professor of Hydraulic and Maritime Construction at the Polytechnic School, Rome.
8. V. de Blocq van Kuffeler, Engineer of the Waterstaat, Hoorn, Netherlands.
9. Albert Lundberg and Wollmar Fellenius, Sweden.
10. A. Hermann, Ingenieur en Chef des Ponts et Chaussées Directeur Général de la Compagnie des Ports de Tunis, Sousse et Sfax.

The subject matter of the communication naturally has led to reports dealing with harbor works that involve (*a*) general types of construction; (*b*) the application of reinforced concrete to such works, and (*c*) the preservation of reinforced concrete in harbor works, with references also to the durability of plain or non-reinforced concrete.

Breakwaters, Jetties and Sea Walls

The fourth question before the Tenth Congress at Milan in 1905 had for its subject "Conditions Affecting the Force of Waves and the Construction of Breakwaters to Resist Them," and eight reports thereon were before the Congress by engineers representing five nations. Since the subject has been discussed by the Congress at such a relatively recent date, the reports now submitted may practically be considered as in continuation of the earlier reports, excepting as they are modified by the application of reinforced concrete methods or other recent developments in construction. Your general reporter is in full accord with the action of the Milan Congress, as well as with the conclusions of earlier Congresses, that the selection of a type or system of construction depends upon a large number of very variable local conditions. The conclusions of the general reporter to the Milan Congress in respect to conditions affecting the force of waves will provide the safest guide to the engineer in his studies for new works, and they were adopted by that Congress. In so far as those conclusions relate to the design of new works, they read that "In projects for new works in the open sea, the engineer will find most valuable information by examining existing works, by taking into comparative consideration the regimen of the swell outside, the shape of the shores and the lay of the bed of the sea in the approaches to the port, and every other condition which may give him useful elements on which to work," and the present writer recommends adhesion to these views without attempt to modify them even though in some details they might be extended and elaborated.

* Lieutenant Colonel, Corps of Engineers, United States Army.

The Application of Reinforced Concrete to Harbor Works

Of the various applications of reinforced concrete to harbor works, the type that is most distinctively peculiar to such works, in contradistinction to structures built for other purposes, are the reinforced concrete caissons or cellular blocks now utilized to permit of massive or monolithic construction of breakwater walls and of retaining or other walls for interior harbor works and to avoid the placing of green concrete under water. These methods have largely superseded for such works the steel caissons with manifest advantages, and form in effect permanent sectional cofferdams within which operations can proceed in the dry, with more economical mixtures than are permissible in subaqueous concrete or in block work, and even in some instances with a filling only of sand, stone or other ballast without mortar. For wharves and landing piers and similar purposes the application of reinforced concrete continues to progress rapidly, as it is also for bank protection.

If any conclusion can be formally stated upon this subject the general reporter would recommend as follows:

Experience to the present time demonstrates that the engineer has in reinforced concrete a valuable device suitable for application to a wide and increasing variety of structures, and it merely rests with him to develop it further and apply it properly. Many heretofore undeveloped or obscure points in theory and in practice have been cleared up, but others remain for further study, and in this direction, as well as in the improvement of the details of design, lie the most important fields for future investigation.

The Preservation of Reinforced Concrete in Harbor Works

There still remains much doubt in the minds of engineers as to the reliability and permanence of reinforced concrete immersed in sea water or exposed to its effects. This doubt arises primarily from uncertainty regarding the effect of sea water upon the Portland cement or other binder employed in the mortar of the concrete, since if the concrete is properly proportioned and put into place, and if it continues sound and intact, little remains to be done for the preservation of the steel. The problem, therefore, in its essential features, resolves itself into the employment of a cement or mortar unaffected by sea water and its utilization in such a manner as will prevent access of sea water to the interior of the concrete and to the steel, with such additional precautions as experience may show to be efficacious. This short statement of the case is simple in terms, but its solution rests upon the determination of the most suitable cement and mortar to produce permanent results when used in concrete placed in sea water, which question has for years been before engineers for solution, and now has increased importance through the advent of reinforced concrete. In one respect, however, the problem is less difficult than would otherwise be the case, since it is only in rare instances that reinforced concrete cannot be seasoned before being exposed to sea water, and methods for its preservation can be employed under these circumstances that are not available for subaqueous work, with its attendant difficulties and possible defects.

The writer is of the opinion that in good, sound concrete, plain or reinforced, the engineer has a most valuable device adaptable to meet many conditions in maritime works; that if designed with good judgment and applied with discretion it

will permit of the execution of works that might otherwise be financially or physically impracticable and will ordinarily permit of economy in permanent works; that it is reasonably permanent in sea water if applied with all the precautions that experience to the present time has suggested, and that further experience may provide additional means for increasing its reliability; but that no precaution should be omitted in its application. He would not, however, be considered as advocating the use of concrete under any and all conditions, and recognizes that in some situations other materials, alone or combined with concrete, give better or more economical or more permanent results.

It is evident from the reports before the Congress, and more especially from the current literature upon this subject, that experience with reinforced concrete in sea water has not, to the present time, covered a period sufficiently long to permit of laying down conclusions in detail as to the best methods to be followed for its preservation. With longer experience such conclusions might be so formulated as to meet the approval of the Congress, and some of them might be put forward at this time. It would seem, however, to be wise merely to refer to the experience heretofore gained in the matter of such details, as contained in the reports before the Congress or as found elsewhere, and to defer action by the Congress on such matters until conclusions thereon may be supported by such further experience as will enable the Congress to adopt them with greater assurance as to their sufficiency.

Only the following general conclusions are therefore submitted for the action of the Congress:

1. Further experience tends to confirm the conclusion of the Congress of 1908 that the earlier results of the application of reinforced concrete to hydraulic and maritime works are encouraging, and to indicate that reinforced concrete may be expected to be reasonably permanent in sea water if the precautions necessary to secure that end are intelligently and unremittingly exercised in accordance with the best experience in such works.

2. In view of the comparative novelty of this type of construction, its increasingly wide application, and the rapidly growing experience in its use, this subject should again be made a question for consideration at the next Congress.

3d Communication: Review of Reports on Bridges and Ferry Bridges, Tunnels under Waterways Used for Ocean Navigation

GENERAL REPORT BY WILLIAM H. BURR*

While these reports disclose a fairly uniform judgment as to certain main features of the broad questions under discussion, they further show that the choice between the various proposed methods of crossing an ocean navigation waterway by land traffic must frequently, and perhaps generally, be determined on its own merits by the consideration of local conditions in connection with careful estimates of cost of construction (including land), maintenance and operation.

The main practice, both in the United States and in Europe, up to the present time has been in the direction of ferries and bridges, although within the past five years resort to tunnels has been made chiefly, but not wholly, at New York. Bridges of one form or another have been almost entirely used in Germany, France and England at points where dense ocean navigation exists, but the unsatisfactory character of such means of crossing intensely used maritime channels is becoming pressingly evident.

It would seem that the tunnels already constructed at New York, Hamburg and other points are but the beginning of further and wide choice of the tunnel plan where ocean-going traffic is materially increasing in density.

Movable bridges, such as the various types of swing bridges and bascule bridges, are available for the crossing of maritime channels where the navigation traffic and the land traffic are not concurrently dense or of large volume. If the navigation traffic is of such volume and importance that it can suffer but little interference, the method of crossing it by movable bridges is feasible, provided the land traffic is relatively light, so that the movable bridges may either be frequently opened or remain open a considerable part of the time. On the other hand, if the maritime traffic is light and the land traffic is heavy, the use of movable bridges means that the channel shall not be opened frequently nor during any considerable part of the time. Essentially the same observations may be made in connection with the transporter or ferry bridges, although a dense land traffic cannot be so conveniently or efficiently handled by them as with swing or bascule bridges. On the other hand, they are less obstructive to the movement of maritime traffic, and they afford the most direct and convenient communication between the shores of the channel without elevation of grade and with least occupation of shore space. It has been aptly said in one of the reports that the ferry bridge occupies an intermediate position between ferries and high permanent bridges.

Permanent bridges are permissible only where the vessels engaged in maritime traffic have parts not too high to pass under such structures. While, therefore, such bridges affording not more than 50 feet clear headway may pass considerable volumes of water traffic they must be and are usually limited to coastwise or inland traffic, such as along the large rivers of the United States and some of the smaller rivers of Europe.

Investigation of the utility of high permanent bridges in the reports indicates that there may be serious competition in some localities between tunnels under channels for maritime traffic and permanent bridges with clear head room enough for the highest masts of ships now found, reaching in some cases nearly 220 feet. The long ramp approaches of both tunnels and high permanent bridges constitute serious features of their construction and operation. It appears that a tunnel placed at sufficient depth to accommodate either present or future navigation traffic provided with lifts instead of ramp approaches is more economical than a high permanent bridge with the approaches required for relatively low ground on both sides of the channel. If the tunnel must be provided with ramp approaches, as for railway traffic, the choice between the high permanent bridge and the tunnel will depend upon local conditions, which must be carefully considered in making a comparison as to all the elements of the problem, including costs of construction, real estate, costs of operation, maintenance, etc. In general it may be stated that high permanent bridges possess clear advantages over tunnels only when the maritime channel lies along an enclosed valley with rapidly rising ground on either side so as to reduce the costs of the bridge approaches and the further cost of elevating the traffic on one side and carrying it down to the low ground on the other; or when the depth of water in the channel is so great that the depression of the tunnel grade prohibits tunnel construction.

The reporters do not appear to have considered the advantage of using lifts or elevators at either extremity of high permanent bridges, which obviously is similar to the advantage of the same device at the extremities of a tunnel, except that, approximately speaking, the depression of a tunnel will generally be not more than one-half of the elevation necessitated by a high permanent bridge.

The advantages of ferries, including both ferryboats for passengers and vehicle traffic and car floats for the transportation of trains of freight cars across wide channels for ocean

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navigation, have been conclusively established at New York, where enormous volumes of land traffic are transported in this way across such channels. Similar transportation by large, self-propelled car floats is satisfactorily maintained on the Great Lakes and across Detroit River in the United States. In the face of the situation, however, tunnels have recently been built under the wide channels of the Detroit River and of the East and North Rivers at New York, but thus far for passenger traffic only at the latter point. It is doubtful whether freight traffic will be accommodated under the East and North Rivers in this manner in the immediate future, although it is not improbable that tunnels for the passage of freight may be constructed in the near future.

The following conclusions may be drawn from the results of the investigations set forth in these reports:

1. Where maritime channels carry ocean navigation of large amount or of such great density as is now found in a few of the largest ports of the United States and Europe, means of crossing them must be employed which will not obstruct such navigation to any sensible extent.

2. In maritime channels where ocean navigation is of considerable volume or density, but not so dense as in the greatest ports of Europe and America, the plans for crossing those channels must be such as will give preference of right of way to the ocean navigation, *i. e.*, the service to the land traffic must be subordinated to the requirements of the ocean navigation.

3. Plans for the crossing of maritime channels which involve considerable obstruction to navigation can only be recommended where the ocean navigation is light or of small amount concurrently with a heavy land traffic of corresponding importance.

4. Channels for ocean navigation wider than about 2,000 feet offer advantageous conditions for the use of ferries, including ferryboats for passenger and vehicle traffic and car floats, either self-propelled or propelled by tugs.

5. Channels about 2,000 feet or more in width will preferably be crossed by tunnels when the ocean navigation becomes so dense as to be seriously inconvenienced or obstructed by the passage of ferryboats, or when the volume or rapidity of service required by passengers and vehicle traffic, or freight traffic, is demanded beyond that which can be furnished by ferry.

6. Movable bridges may be employed for the crossing of channels for ocean navigation when the width does not exceed about 500 feet, and if the ocean navigation is not dense enough to prevent the closing of such bridges sufficiently to accommodate the land traffic.

7. Transporter bridges may be used advantageously up to any length of span permissible for a stiffened suspension bridge even when the channel carries a comparatively dense ocean traffic, if the land traffic is not of too great volume.

8. Tunnels may be used advantageously for heavy land traffic under channels carrying ocean navigation so dense as to preclude the use of movable spans and where high permanent bridges are not permissible on the score of economy or for other reasons, or where transporter bridges are not permissible for carrying railway or other traffic.

9. The use of lifts or elevators for passengers and vehicle traffic in connection with tunnels and high permanent bridges is recommended.

10. High permanent bridges are recommended where the maritime channel is flanked by rapidly rising ground, so as to eliminate costly approaches, or where great depth of water precludes a tunnel.

11. The selection of a suitable plan for crossing a maritime channel, so located and conditioned as to make the controlling elements not so well defined as in the cases covered by the preceding recommendations, must be made after a careful examination of all the circumstances affecting the problem, including complete comparative estimates of cost covering construction, land, maintenance, operation, etc.

4th Communication: Safety of Navigation—Lighted Buoys

GENERAL REPORT BY G. R. PUTNAM*

Six papers have been presented, one on the general subject of safety of navigation and the others on lighted buoys and other aids to navigation; several of the latter papers are in effect descriptions of the lighthouse services and systems of the respective countries.

The report of Mr. G. de Joly, chief engineer of Central Service of Lighthouses and Beacons of France, deals with the illumination of the coasts of that country by gas-lighted buoys and by light-vesels. Buoys lighted by electricity or by mineral oil have not been used, but oil-gas buoys have been extensively employed. In order to increase the luminous intensity all of the oil-lighted buoys have upright incandescent mantles. This form of mantle, made of artificial silk, has been found preferable in the French service.

Some coal-gas buoys have been used recently. Tests have been made with Blau gas, but the difference in efficiency does not warrant the French service in abandoning their present oil-gas plants. Acetylene gas has not been adopted for buoys in France, but it is used for some beacons, with mantles to give an incandescent light. The life of the mantles has been found very much less than with oil-gas.

A report of the lighted buoys of the Prussian coast is furnished by Herr Regierungsbaumeister Braun, of Berlin. For these buoys oil-gas, and more recently Blau gas, have been used, the latter being preferred. A few buoys have been lighted electrically or with petroleum. Experiments are being made on the treble mirror, which has the property of reflecting back a beam of light falling on it. Several of these mirrors mounted on a buoy cause it to be visible at a distance of several sea miles by ships carrying searchlights. Suspended gas mantles are preferred. If occasion requires, the lighted buoys are fitted with fog signals, either bell or whistle. There has been in use for over a year a lighted buoy having a submarine bell worked by gas pressure from the buoy, and an unwatched lightship is now being fitted with a similar submarine signal. Extensive tests are being made of the mooring chain for buoys. A description is given of the manufacture of oil-gas and Blau gas.

The paper of Mr. D. A. Stevenson, of Edinburgh, engineer to the Commissioners of Northern Lighthouses, Scotland, states that the lighted buoy is the greatest aid to navigation produced during recent years. Some waterways, as, for instance, the Clyde, are now lighted like a street at night. Some history is given of the development of gas buoys, and mention is made of all different types of gas buoys, including the various kinds of acetylene buoys. Reference is also made to unmanned vessels having gas lights. Mention is made of the various types of flashing mechanism in connection with gas buoys, and the writer states that an automatic acetylene fog gun has lately been introduced in which the consumption of gas does not exceed that of an ordinary gas-lighted buoy, and the flash from the gun may also be used as the light for the buoy or beacon.

Mr. van Braam van Vloten, engineer to the Lighting Service of Holland, furnishes a paper on the lighting of that coast. A general description is given of the organization of the service of lighting and buoying the coasts of Holland.

In 1906 a plan was approved for the improvement of the lighting of the Dutch coast, which had previously been mainly by fixed or flash lights, using petroleum wick lamps. Four of the most important coast lights have been reconstructed with

* Commissioner of Lighthouses, Washington.

electric flash lights, and eight other lighthouses have been fitted with incandescent oil vapor lights. The illumination on several of the lightships has also been improved.

It is proposed to improve the 130 fixed and secondary lights by the introduction of either rich or Blau gas, and giving them suitable characteristics. A clockwork for lighting and extinguishing the flame has been fitted to some lights. A description is given of the new depot for lighthouse work.

There are 95 lighted buoys on the Dutch coast, all on the Pintsch system, and many of them are fitted with incandescent mantles.

Observations have been made of the visibility of lights. They prove the fallacy of the frequently repeated statement that the old petroleum lights penetrate through the fog better than the electric flash light.

A paper on the automatic lighting of lighthouses, lightships and light buoys in Sweden is presented by Mr. Grönvall, chief engineer in the Lighthouse Service of Sweden.

On account of the intricate coast the Swedish Lighthouse Department has endeavored to develop a system for automatic lighting at stations where fog signals, or a very strong light, are not needed. Pintsch buoys and calcium carbide buoys have been tried. Difficulties which were found were obviated by the use of the French invention of dissolved acetylene gas, the first trial in a buoy being in 1904. An apparatus for giving intermittent lights was invented by Engineer Dalén. The advantage of this arrangement is the light characteristic and the saving in gas. Ordinarily about one-tenth of the gas is consumed that would be required for a continuous light. Engineer Dalén has also invented a sun valve, which automatically opens and closes the gas supply in the evening and morning, and saves about 30 percent of the gas. Details are given as to gas consumption and the capacity of the gas accumulators for different classes of aids to navigation. The lanterns have been improved by an arrangement of the bars, so that very little light is lost.

The paper by Col. John Millis, United States Engineers, on the safety of navigation on the Great American Lakes, gives an analysis of accidents in connection with navigation on the Great Lakes of North America during the past ten years, and deduces therefrom suggestions toward greater safety of navigation.

The following information not covered by the papers presented is added by the reporter:

A clock mechanism has been introduced in the English Lighthouse Service for the purpose of turning on and cutting off the supply of gas for buoys and unattended beacons and light-vessels. This clock has been in use on buoys for over a year with satisfactory results.

The United States Lighthouse Service maintains at present 287 lighted buoys, the larger part being Pintsch gas buoys, and the remainder three different types of acetylene gas buoys. The great extent of the coasts to be guarded by this service makes it desirable to use different systems according to local conditions. The gas buoy has been found a very valuable aid to navigation, as it may be placed in locations where it would be difficult to maintain either light-vesels or lighthouses. In comparison with these the original expense of installation and the expense of maintenance is small, so that for a given expenditure more valuable results can often be obtained with lighted buoys.

Fifty-five of the gas buoys are provided also with sound signals, either in the form of whistles or bells. Test is now being made of a lighted buoy having a submarine bell attachment. In this buoy the movement due to the waves imparts a vertical motion to a fin and operates to store power in a spring, which, when automatically released, causes the bell to be struck. Preliminary reports from this submarine bell buoy are favorable.

Subaqueous Rock Excavation

While in Europe the use of the rock breaker in subaqueous work has been attended with some success, in the United States it has been found to give better results if a drill boat with five or six drills operating at the same time are used to drill holes for blasting. In the former case the rock for a shallow depth is broken into small pieces which can easily be handled by an elevator dredge of moderate power. Where the depth of the rock to be excavated is great it is found better to go over an area with a rock dipper two or three times, cleaning up after each time with a dredge. In the latter case the holes are drilled 5 feet below the grade no matter what the depth is, and the blasting is done so as to break up the material into pieces which can be lifted by the teeth of a large dipper dredge bucket. It may readily be seen that pieces which could not possibly be brought up with an elevator dredge can be handled easily with the dipper. The result of using the drill boat and the large dipper dredge in connection with each other is that each machine goes once over the area and entirely completes its work as it goes along. There is therefore less time lost in moving, and the work, of course, is done more economically.

On some large dipper dredges in use in the United States for subaqueous rock excavation the bail pull, or pull of the dipper by the hoisting rope, is as high as 200,000 pounds, and this pull is often concentrated on one dipper tooth, so that the pull, which can be exerted on any particular rock, is enormous. With an expert runner and cranesman on a large dipper dredge it is possible to feel around on the bottom with a dipper and determine how the large pieces lie and how they can best be attacked. This is something which is absolutely impossible with an elevator dredge.

On the large dipper dredge the large stones which are picked up come in contact only with the dipper and the dipper teeth. A spare dipper is always kept on hand and the teeth can be quickly renewed. On the elevator, on the contrary, every piece of rock which is brought up by a bucket is apt to come in contact with the lower tumbler, the sides of the ladder well, the sides of the hopper and the bottom of the hopper and chutes.

The elevator dredge operates entirely on mooring lines, which leave the vessel near the waterline, while the point of contact of the buckets with the material being excavated is far below the waterline. This makes it extremely difficult either to force the machine into the material until the machine is stalled or to regulate the strain which is thrown on the machine in getting out any particular piece.

The dipper dredge is not moored by lines but is "pinned up" by means of heavy timber legs called "spuds." In the most modern dipper dredges the dredge is pinned up by means of an independent engine, operating each forward spud so that the two spuds may be operated independently of each other. These spud engines are powerful enough to throw a large part of the weight of the forward part of the dredge on the spuds, thereby giving a solid platform and preventing the dredge from kicking back or swinging on account of the resistance offered by the material being dug.

Most of the dipper dredges used in subaqueous rock excavation have a dipper with a capacity of 6 cubic yards, although there are some of 10 cubic yards capacity, and one working along the coast of New England with a dipper which has a capacity of 15 cubic yards. This latter dredge is designed so as to work very efficiently to a depth of 55 feet below the water surface. This allows the dredge to dig several feet below grade at extreme high tide and produce a channel with a depth to grade of 40 feet.

The large dipper dredge for subaqueous rock excavation has entirely passed the experimental stage, and is now invariably used in the United States for this work.

Mechanical Equipment of Sea Port and Inland Waterway Terminals

BY H. McL. HARDING *

A terminal for waterborne freight does not consist of a pier or quay only, to or from the edge of which the ship's winch can transfer freight. To satisfy the modern requirements of freight transference there must be co-ordinated with the piers, sheds correctly designed for high tiering, car track space and dray areas, each with their respective shedded platforms and the warehouses for long storage. These should be so located, with respect to each other, that the work at each may proceed without interference from the others, and not, as is often the custom, so arranged that there should be huddled together upon the dray floor the trucks, drays, cars, held-over freight, both outbound and inbound, and, besides this, all the moving operations.

A terminal properly equipped for handling miscellaneous cargoes should have mechanical facilities for the rapid and economical transference between all the elements of a terminal and between all the freight carriers at such a terminal, whether ocean liners, coastwise ships, harbor lighters, river barges, freight cars or drays. Between all of the above elements there are the movements of freight from one carrier to the other, both loading and discharging. All such movements should be studied by engineers from actual observation before any type of mechanical equipment should be recommended.

As this paper is intended to be of general application it should be kept in mind that there are many exceptions to the general principles. As stated, the following are some of the most important freight movements, all of which should be performed by machinery, and provision for any one of which should never be neglected.

One of these is the transhipments between different steamships, as ocean liners and coastwise ships, canal or river boats. These ships are generally located at different piers or remote quays, and the transference is chiefly effected by means of lighters, which are the water drays, but having a carrying capacity of 400 to 600 tons, instead of the 2 to 4 tons of the land drays. The lighter is the economical means of harbor transport. It is not practicable for a large steamship to call at different piers to receive or discharge portions of miscellaneous cargo. This is largely the lighterage service.

The cargo from a foreign or coastwise steamship may be for a dozen or more different water or rail connections about a port. This cargo consists of cases, boxes, barrels, bales or crates, and the same draft from the hatch often contains different marks, which must be separated and inspected before each can be routed for its destination. It is therefore necessary with such freight that it pass upon or over the pier. Provision should therefore be made in the design of a pier of the jutting or projecting type, for the berthing of a number of lighters at the same time and the corresponding mechanical equipment.

PRESENT APPEARANCE OF RIVER LEVEE

At the port of New York these lighters are from 80 to 100 or more feet in length, and require one or two men. When loaded they are generally towed by tugs about the port. The average rate for these harbor tugs is about $10 (£2 1s. 8d.) an hour. This may be for a lighter load of 600 tons. The rate of a two-horse dray averages $1.00 (4s. 2d.) per hour for 2 tons.

One approved method of berthing is for the steamship to be upon one side of the pier and for the lighters to be on the other, and also fore and aft of the ship, if there be any space there. While much of the outgoing package freight can be loaded over the ship's side yet not more than 10 percent of the inbound freight is thus transferred. Portions of the cargo may be for warehouses located at other terminals, and this transport also should be by lighters. In some instances as many as forty lighters are congregated about a single pier, and sometimes in three parallel lines.

From the cursory description of lighterage the necessity for providing machinery for the movements between steamships and lighters is self-evident. Very wide piers with two rows of sheds, with cars or sheds between, seriously interfere with lighterage. This has been proved by experience and it is well

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known to every terminal agent. It is desirable to keep the pier floor as clear as possible for the inspection, routing and the temporary holding of the freight.

Inbound freight often should be taken to the bulkhead shed, even to the second story, when it is to be held only a short time over the free storage period, and it is not desired to have incurred the warehouse charges. This is often granted as an accommodation to large shippers and consignees. On account of the great expense of handling, or rather rehandling, freight is frequently suffered to remain upon the pier floor, though in the way, and sometimes it is necessary to move it several times. This generally happens when the stevedore is selecting freight of different kinds for proper stowage.

The next important transference is between the vessels and cars, or rather the car platforms, as in the United States the box-car is almost exclusively used for package freight.

When the hand-truck was used in freight handling on or about the piers, to reduce the hand-trucking distance it was deemed advisable that the cars should pass upon the piers. There was this great disadvantage in this that the cars occupied valuable and expensive pier floor space which should have been reserved for freight storage. It also prevented direct movements across the piers. Upon many of the piers at the port of New York such car tracks, though formerly laid, have now been removed.

Another disadvantage of having the cars upon these projecting piers is the dividing of the pier into sections by depressing the tracks so as to have the pier floor and the car floor upon the same level. This means that the cars must either themselves constitute bridges or else movable lifting bridges must be provided, which are unwieldy and cumbersome, and must be removed during car shifting. Where there are two or more lines of tracks the condition is worse

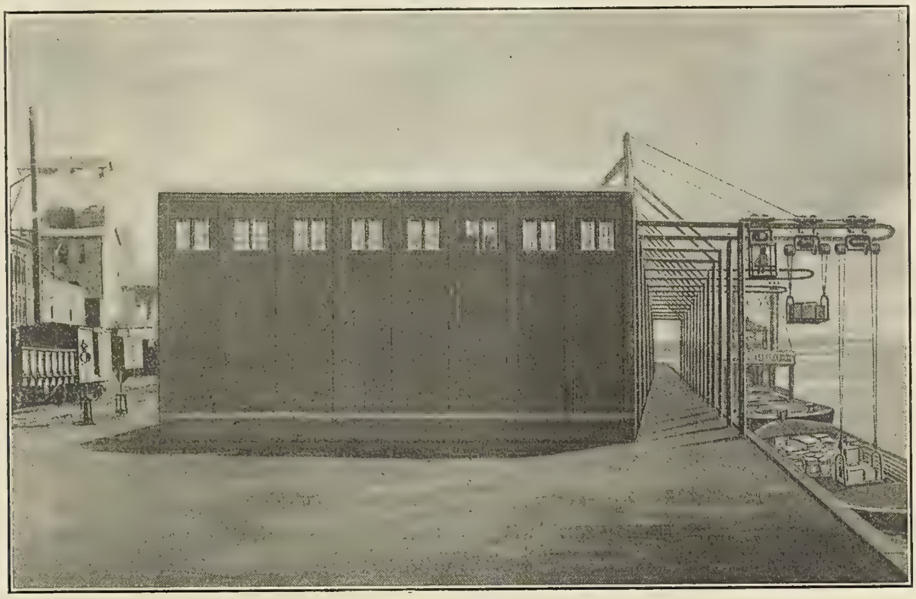
If the car tracks and the pier floor are upon the same level, freight must be lifted about 4 feet when placed in the car or upon a movable platform in front of the car door.

It is preferable to run the tracks at right angles to the pier length but close to the head of the pier upon the shore, the same as is the custom where there is a continuous quay wall similar to the track arrangement at many European ports. Between each parallel line of tracks there should be a platform which here can be made level with the car floor without detriment. The freight movement between the vessel and the thus located car platforms should not only receive attention but also the movements between any portion of the pier floor and these platforms, as it often happens that cars for certain cities are not available, and the freight, though eventually for the cars, must be held upon the piers.

The third movement is between the vessels and the dray areas and platforms. In many cases, especially with outbound freight, the drays may pass upon the piers, and arrangements should be made for this, but so much of the pier floor would have to be reserved for this purpose it is better wherever possible to avoid it, as being able to unload upon platforms instead of upon the floor is advisable.

The dray area should therefore be placed to the rear of the car tracks. By means of a correctly designed system of mechanical transferring, this freight also can be handled economically and expeditiously. The advantage is especially marked in connection with the local inbound freight, which can be routed at once to these dray area platforms.

The outbound freight, instead of being dropped, as is the custom, often 10 feet from the top of a drayload to the pier floor, or to minimize the breakage directed to strike the dray wheel in its descent, is unloaded upon flatboards placed upon the platforms, or may be taken from the dray to the vessel or to the space upon the pier floor near the hatch. If placed upon flatboards upon the platforms the flatboards with their loads are carried to the vessel.



RIVER LEVEE IMPROVED. HINGED LOOPS EXTENDING OUT OVER THE BARGES, TRANSFER TRACTORS WITH HOISTS RAISING THE LOAD

The freight-holding capacity of a pier can be doubled if drays are kept off the pier floor. The inbound freight can be taken from the vessel from the ship's fall or from the side of the pier to the inbound platform in the dray area by one movement without interference or rehandling.

From these platforms the freight can be taken by the drays for local destinations without interfering with the ship's loading or discharging. The freight, however, can only be economically transported by the installation of long-distance hoisting and conveying machinery.

The warehouse constitutes an essential element at all terminals. Inbound freight must be moved from the pier after being held a limited time, the rule often being after forty-eight or seventy-two hours. This time limit is necessary to prevent congestion on the piers or on the quays. In the movement between the pier or the vessel and the warehouse it should be possible to transfer the freight even to the second or third story of the warehouse.

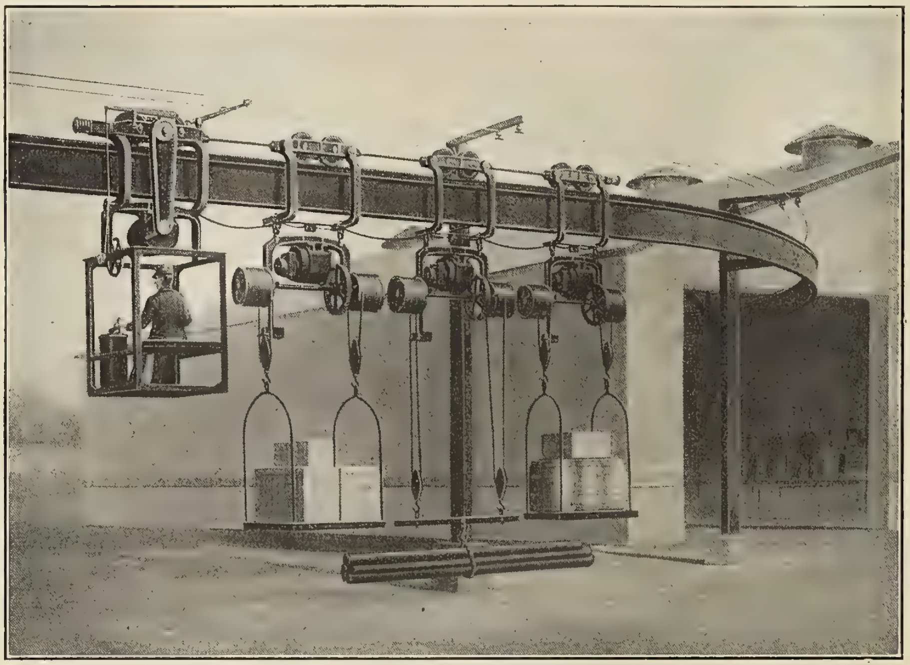
There are therefore at seaboard terminals six principal

freight movements and the corresponding reverse movements. A careful study of all the present methods of freight handling indicates most conclusively that any system to be successful, and to avoid expensive rehandling, must be a combination of hoisting and conveying. It often happens that the lifting is equally important with the conveying. This hoisting is necessary that the machinery may be able to elevate the loads so that they can pass over intervening obstructions and serve different levels, and also avoid the reserving of valuable floor space for traveling.

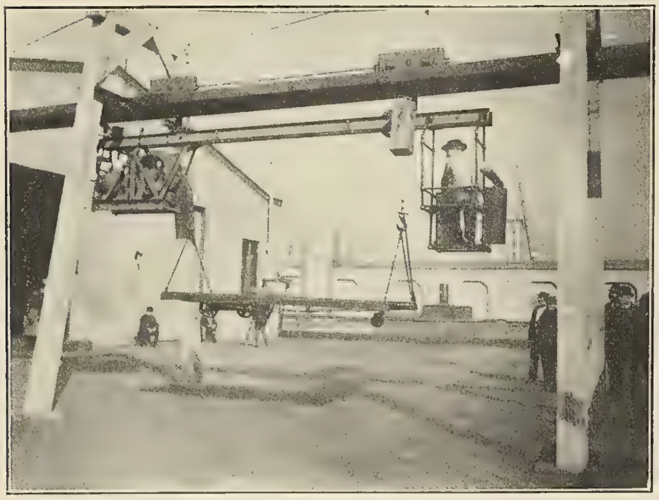
Harbor improvements are exceedingly expensive, and to build more piers or quays which would be used for surface conveying hardly seems like economy, especially as the conveying by the later types of machinery can be overhead and without interference, practically continuous.

To secure anywhere near the capacity of a pier there should also be high tiering. Five feet is the usual average height of tiering by hand. If this average can be increased to 15 feet, the holding capacity of a pier is tripled; and if to secure this capacity little or no floor space is occupied in the conveying, there would be eliminated floor interference or congestion.

Any machinery should be able to fulfill economically and with rapidity all of the above described freight movements between the vessel, the lighter, a remote portion of the pier or bulkhead, the car or dray platform and the warehouse. These movements should be approximately in circuits or loops, regardless of surface obstructions, the loads being conveyed without interference with each other.



THE TRANSFER TRACTOR AND THREE TRAILER HOISTS. EACH HOIST RAISES A SEPARATE CONSIGNMENT



OVERHEAD TRANSFERRING AND HOISTING MACHINERY

The conveying and hoisting machinery in its operation should not be compelled to wait for the loading or unloading of flatboards, nets or other carriers. That which contains the load should be independent of the tractor unit, just as a locomotive is independent of the freight cars.

Not only must the same machinery hoist and convey but it should be able to distribute and assort. To accomplish this the consignments should be kept separated according to the marks when being hoisted and conveyed.

Where desired the ship's winches can hoist the loads from the hold, and place them upon the vessel's deck or upon the side of the pier, the rest of the transferring being by means of the overhead carrier. The overhead hoisting and transferring mechanism can, however, perform all the movements.

That method of hoisting and conveying which seems to be of the most universal application is what is known as transference, and consists of overhead tracks or runways, some of which are fixed and some movable.

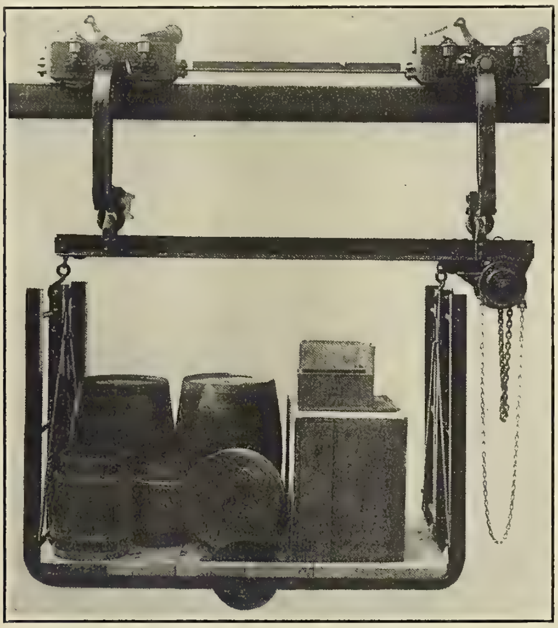
Suspended from these tracks is the conveying mechanism. This consists of trains composed of a transfer tractor or electric conveyor, which draws after it a number of transfer trailers. From each of these trailers is suspended an electric hoist. One man in a cab controls the conveying and hoisting.

Of the movable tracks, some are in the form of loops, and other tracks are attached to traveling cranes, and are connected with the side tracks by gliding switches. By these tracks every cubical foot of space can be served, either the hatches and decks of the vessels or the pier floor, the car or dray-area platforms or even the warehouses.

The loads, kept separate as to consignments, can be hoisted from any place on the terminal and conveyed to any other

place by one transferring movement, loads following one another continuously. All of the above movements are affected without rehandling by manual labor.

The above may be said to be the latest advance in terminal cargo transference. Long-distance transferring machinery, independent of levels, greatly simplifies the design of port terminals. By avoiding rehandling there is less breakage, greater rapidity of transference and less expense. Even rehandling costs at least 15 to 20 cents (7½d. to 10d.) per ton for labor only. By confining the movements to the overhead there is not the congestion or interference which may be observed to be the usual condition at large terminals. The loads can be placed upon car or dray-area platforms a thousand or more feet from the pier as easily as upon the opposite side of



DETAILS OF TRAILER AND TRUCK

the pier. It costs little more to transfer by such machinery 1,000 feet than it does 500 feet, and no more to tier than to place upon the floor.

By being able to transport the freight without a material increase in cost to areas or warehouses at the rear of the piers, or even to places removed from the waterfront where land is economically available, means a great increase in the capacity of a terminal, and far less expenditures for the port development. This one feature of increased capacity would reimburse by many times any expenditure made for the mechanical installations. Besides the economies secured substituting such machinery for manual labor, there is also greater rapidity in loading and discharging.

The machinery which has formerly been employed for handling general cargo in addition to the ship's winches consisted chiefly in some form of the traveling gantry crane. The development of these cranes has been in the direction of obtaining greater range, thereby clearly recognizing their limitations. Their range has been within a radius of 50 feet from the edge of the pier and that opposite the hatch which they were serving. As they are unable to transfer the goods "up and down" the pier, or to any distances within the pier shed, this work has generally been performed by manual labor. The relative proportion of costs of these two movements are 3 cents (1½d.) per ton for the ship's winch or gantry crane and 30 cents (1s. 3d.) for the later manual labor.

The advantages of the recent improvements in mechanical transference over the present primitive methods therefore may be summarized:

A reduction in terminal handling costs to at least one-half, and a similar saving in the time of ship detention.

Increased storage and transferring capacity of terminals.

Saving in port investment.

Better service to the shippers and consignees.

Less losses from breakage and damage claims.

Avoidance of labor troubles and a better utilization of lands for industrial and manufacturing purposes though located several thousand feet to the rear of the waterfront.

The terminals for inland navigation, especially on the rivers, should be of quay-wall construction or else of wood or concrete piles. There is often a great variation, as upon the Mississippi and its tributaries, between the high and low-water levels, and this should receive consideration in the design of such river terminals and the kind of machinery to be installed. In most cases overhead runways equipped with transfer tractors and transfer trailer hoists above described will best fulfill the requirements, as by this class of hoisting machinery the height of the river does not effect the transference, the difference between high and low water meaning only a few feet more or less of hoisting.

Quarterly Report of Progress of U. S. Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		May 1.
Wyoming	27,000	20½	Wm. Cramp & Sons	97.0
Arkansas	27,000	20½	New York Shipbuilding Co	96.0
New York	28,000	21	Navy Yard, New York	35.3
Texas	28,000	21	Newport News Shipbuilding Co	61.9
Nevada	28,000	20½	Fore River Shipbuilding Co	0.0
Oklahoma	28,000	20½	New York Shipbuilding Co	0.7

TORPEDO BOAT DESTROYERS

Fanning	742	29½	Newport News Shipbuilding Co	89.9
Jarvis	742	29½	New York Shipbuilding Co	80.2
Henley	742	29½	Fore River Shipbuilding Co	75.1
Beale	742	29½	Wm. Cramp & Sons	78.9
Jouett	742	29½	Bath Iron Works	97.9
Jenkins	742	29½	Bath Iron Works	93.3
Cassin	742	29½	Bath Iron Works	15.6
Cummings	742	29½	Bath Iron Works	15.5
Downes	742	29½	New York Shipbuilding Co	10.7
Duncan	742	29½	Fore River Shipbuilding Co	18.1
Aylwin	742	29½	Wm. Cramp & Sons	18.4
Parker	742	29½	Wm. Cramp & Sons	16.4
Benham	742	29½	Wm. Cramp & Sons	17.1
Balch	742	29½	Wm. Cramp & Sons	14.4

SUBMARINE TORPEDO BOATS

F-1	....	....	Union Iron Works	96.6
F-2	....	....	Union Iron Works	92.7
F-3	....	....	Seattle Con. & D. D. Co	91.3
F-4	....	....	Seattle Con. & D. D. Co	90.6
G-4	....	....	Wm. Cramp & Sons	73.5
G-2	....	....	Newport News Shipbuilding Co	85.8
G-1	....	....	Lake T. B. Co	90.2
H-1	....	....	Union Iron Works	66.3
H-2	....	....	Union Iron Works	66.5
H-3	....	....	Seattle Con. & D. D. Co	63.6
G-3	....	....	Lake T. B. Co	46.6
K-1	....	....	Fore River Shipbuilding Co	30.8
K-2	....	....	Fore River Shipbuilding Co	30.1
K-3	....	....	Union Iron Works	36.6
K-4	....	....	Seattle Con. & D. D. Co	30.2
K-5	....	....	Fore River Shipbuilding Co	13.5
K-6	....	....	Fore River Shipbuilding Co	13.5
K-7	....	....	Union Iron Works	17.5
K-8	....	....	Union Iron Works	17.5

COLLIERS

Proteus	20,000	14	Newport News Shipbuilding Co	54.8
Nereus	20,000	14	Newport News Shipbuilding Co	46.9
Orion	20,000	14	Maryland Steel Co	77.1
Jason	20,000	14	Maryland Steel Co	36.9
Jupiter	20,000	14	Navy Yard, Mare Island	62.0

The Spanish drydock, capable of accommodating vessels of 12,000 tons gross register, which was captured as a prize by the United States during the Spanish War, has been towed to New York from Pensacola, Fla. The dock will go into commission in the New York harbor for the service of the United States Government.

Inland Water-Borne Commerce in the United States

BY JOHN RUDDLE, M. E., C. E.

Inland water-borne commerce in the United States is in a state of arrested development because it so happened that, in the development of the human race, the railroad, as a means of transportation, arrived at a sufficient state of perfection to carry traffic economically before the great development of farming, mining and manufacturing took place. When they were to be developed the railroads were ready to serve them. In fact in many instances, long before the industrial development took place, the railroad was there ready for service. The consequence was that all developments that required transportation facilities took place along the railroads, rather than along the rivers, and caused the railroad traffic to develop instead of the water traffic. In this respect the situation in the United States is directly opposite to the situation in Europe and other countries where the need of transportation developed earlier than the development of the railroad. This historic fact seems to be forgotten or ignored when comparison is made between the backward development of water transportation in the United States when compared with Europe.

Not only is this historic fact ignored, but it seems to be assumed, or at least the element of time is ignored when the assumption of certainty is made, that when the rivers and water courses are "improved" water-borne commerce will immediately grow to large proportions and will warrant the expenditure of indefinite sums of money to make the development.

The water-borne commerce of Europe is not the result of sudden growth, nor is the tremendous rail traffic in the United States. Both are the results of years—yes, generations—of cultivation and development and water-borne commerce will come, if it comes at all, only as the result of long years of growth.

There is also a reasonable doubt whether water-borne commerce in the United States will ever reach the relative importance it has in Europe on account of the geographic location of the rivers which must form the basis of the improved waterways. The main mountain ranges, that form the divides between the important valleys, lie in a generally northerly and southerly direction, whereas the seaports from which commerce leaves and enters the country are on the East and West coasts, so that the lines that commerce must travel to and from the main seaports and the center of the country are approximately at right angles to the courses the main rivers follow. This condition in itself will always operate to render ineffective, to a certain extent, all efforts to develop a water traffic that will reach the relative importance that it reaches in Europe, unless, by some herculean effort, commerce be induced to abandon the Atlantic ports for those on the Gulf coast.

Other conditions exist that also emphasize the difference between the two territories. In Europe the improved waterways are largely the result of efforts made directly by those who desired to use them—cities, States and corporations, and when they had expended energy and effort in making the improvements they used them and maintained them, and they became a vital part of the industrial development of the country, and the industries and communities taxed themselves directly for their construction and support. In the United States, however, it is the general government that is expected to build and maintain the waterways out of moneys raised from indirect taxation, so that no part of the community can feel a direct interest by reason of having spent its own money and effort. As a consequence there can never be any strong feeling of pride on the part of any community in the development and use of the waterway. The only incentive to use it will be the one of profit, and that takes in so many considerations that in only exceptional cases will the expenditure of money for improvements be warranted.

But the improvement of the rivers for navigation will come and should come, because, though they may not be necessary at the present time or for many years to come, the time will come, when the density of population approaches that of Europe, when the railroads will be only too glad to be relieved of handling a large amount of traffic they are now glad to carry, and the improvement of the rivers might just as well be made now as at any other time, especially as in after years there may be no River and Harbor Bill to provide funds.

When these various improvements are undertaken, it should be clearly understood that the improvements will not become self-supporting immediately and that, until they do, the necessary funds for maintenance must be borne by the general taxation. If the work was being done by a corporation these funds would be supplied by increasing the amount of the bonds issued against the work, and then a failure to earn the interest charges within a reasonable time would be followed by bankruptcy.

Assuming, however, that the streams are to be improved, it remains to be determined how it can best be done and what amount and kind of work will be the most efficient and the most economical.

In the direction of efficiency the improvements should be made so that they will be available for use by the greatest number; they should not be made for the capitalist, who can command wealth enough to build steamboats, to the exclusion of the man who, from necessity or choice, wishes to use a small boat and move it by towing with a horse or mule. The improvements should be made with a view to the joint and simultaneous use by boats of all suitable sizes, by whatever power they may be moved. This of course means that wherever practicable proper towing paths and lateral roads must be provided for, and these will be especially useful in developing the traffic that moves only short distances. This short distance haul, by the way, will probably, in the course of time, assume large proportions in the aggregate. It will be traffic handled by farmers and those desiring to conduct a small transportation business for hire, who will handle largely farm products to nearby points of consumption, and fertilizer or other commodities in return, thus enabling the markets in the towns to be supplied at a lower cost. Or the farmers, or others, may handle their products from the farm to some point where shipping facilities to more distant points are better, or from which a better market can be reached. This condition will apply especially to canals passing through agricultural countries or where small manufactures are carried on, and where the available tonnage or the possible rates would not warrant the installation of more elaborate transportation facilities at the beginning.

Any improvement, therefore, made at the expense of the general taxpayers should contemplate the use of the improved waterway by all classes of traffic or it will fail of its most vital advantage, that is, the greatest good to the greatest number.

Improvement of Rivers

The manner of improving any river will be determined by the character of the river itself and the nature of the country

through which it flows. If the stream is characterized by very great variations in the amount of water it carries, that is, if at certain seasons there are high floods and at other periods extreme low water, a system of reservoirs to control these conditions will be absolutely necessary. They will be needed, first, to hold back flood water and reduce the amount of damage that may be done to the improvements by floods, and, next, to supply the deficiency of water during the periods of extreme low water. It will be necessary also to provide the necessary means to control the water at all points of the river during low water periods, so that none of it will be wasted and the fullest benefit will be obtained from all the available water in carrying traffic. As water is the *sine qua non* for water-borne traffic, this is the very first question that should be considered in determining the method of improving any river, because this condition is controlled by the laws of nature while all others are in the control of man and may be rectified by a greater or less expenditure of money and effort, but no amount of money or engineering ability can control the rainfall.

Of course as an academic question it may be asserted that even the water supply of any stream can be controlled by pumping the water from another stream, but the mere assertion of the question emphasizes its absurdity from an economical standpoint.

The available water supply having been determined satisfactorily a study of the stream and the character of the country through which it flows will determine the character of the improvements that will best suit the individual case, and every river will have to be treated as a case by itself. In a general way improvements that will be suitable for any one river will not be suitable for any other river except with such great modifications that render each a case by itself.

Rectification of the Natural Channel

Where the particular conditions applying to any stream permit it, this is obviously the most effective and cheapest means of improving, because it involves less expense for maintaining the improved channel and a less cost of operating, there being no locks or similar works that require the continual attention of labor.

Among the conditions controlling the rectification are the normal velocity of the stream, which is controlled by the slope of the bottom and the volume of water carried. Where the normal velocity is low the difficulty of navigating against the current is reduced and the danger of interference with the improved channel by silt carried by the water or by scouring of the banks is reduced to a minimum. The rectification will usually be accomplished by protecting the natural banks at points where they are exposed to the force of the current so that they will not be eroded and the material carried into the channel. This work will be particularly necessary on the outside of the curves at bends in the river, but it will also be necessary at some points at the inside of the bends where the ground is low and there is danger at times of high water that a new channel may be cut across the lowland. Dikes will have to be constructed at such places to prevent overflow.

In some cases where the land is low and the character of the material permits, it will be more desirable to open a new channel across the neck of land and turn the entire stream through it by means of a dam, thus straightening the channel and, usually, by reason of the slight increase of velocity secured, making a channel that will keep itself clear by the scouring action of the water. The material excavated from the new channel will naturally be used to build up the banks and prevent the flooding of the surrounding country.

Sunken trees, loose rocks and other submerged obstructions will have to be removed, and when this, together with what has already been stated, has been accomplished, the simplest and cheapest method of river improvement will have been completed and the natural channel made as navigable as circumstances permit.

Dredging

If greater facilities are required dredging the natural channel will have to be resorted to. If the bottom of the river is of alluvial material this can easily be accomplished and the dredged material can be used to build up the banks at certain points, narrowing the channel and by the increased velocity obtained increasing the scouring action of the stream, either increasing the depth of the improved channel or preventing it from being filled up with silt. It will never be necessary to dredge the full length of any river, as there will always be some points where the natural depth will be sufficient for navigation. It will frequently happen that at some points ledges of rock form obstructions to the improvements. These will have to be removed by blasting unless they are very long, in which case some other method of securing a channel will be indicated.

A controlling factor in improving a channel for navigation by rectifying it is, will the channel after completion maintain itself or must it be maintained by continual attention and repair and renewal of the work that has been done? This will depend largely on the character of the stream itself with regard to the variations in the height of the water, the material composing the bottom of the river and the nature of the banks. If the bottom is composed of light material easily eroded the scouring action of the stream at high water may be depended on to maintain a good depth of water at most points. If the banks are high and composed of material not easily eroded they will confine the water during flood periods and increase its scouring effect. These banks may be either natural or a part of the original design for rectification. Any stream, however, that carries a large amount of solid material will fill up its channel at some points, and provision must be made for maintaining the channel at these points by periodic dredging.

Usually in the improving of a channel by dredging, the disposal of the dredged material, so that it will not find its way back into the channel, becomes a most serious problem. It can be taken from the bed of the channel cheaply by any of the well recognized methods of dredging, but it requires special and expensive equipment to finally dispose of it. If lowland nearby is available it may easily be disposed of by hydraulic dredging and using the material to build up the banks, rendering them less likely to be overflowed during high water, but where such land is not available the material may have to be transported long distances and disposed of by specially designed machinery.

This disposal, together with the character of the bottom of the river, whether it is largely composed of rock or not, and the slope of the bottom controlling the natural current, will be the deciding questions as to whether the improvements shall be by improving the natural channel or by securing the desired depth by means of dams and locks, or by lateral canals, or by a combination of both. A rapid current in the river combined with long periods of low water and rocky bottom will indicate that the desired improvements can best be accomplished by canalization, and by canalization will usually be understood that certain portions of the natural stream will be improved by dams and locks, and these connected by sections of lateral canal of greater or less length, according to local conditions.

The Use of Dams and Locks

Where the bottom of the river is largely composed of rock in ledge it will usually be found that the required depth of water can be more cheaply secured and maintained by means of a dam and lock, even considering the upkeep and operation, than by dredging, and where the slope of the river bed

causes a high velocity a dam and lock becomes imperative. The dam will be built sufficiently high to create a pool of sufficient depth extending up stream far enough to reach water of the necessary depth in the natural or otherwise improved channel. If this distance should be so great that the dam and lock become of an uneconomical height, two or more dams must be used.

Where two or more dams are required and the nature of the surrounding country permits it, it will usually be found that a stretch of lateral canal will be the cheapest because a considerable distance may be saved, the locks will be of less expensive construction and the banks will probably cost less than the series of dams. Maintaining and operating expenses also enter into this determination. The danger of destruction or damage by flood is less in the case of the canal than in the case of the dam; the canal will not be filled with silt from the river requiring dredging; the canal furnishes a convenient harbor of refuge for traffic during flood in the river, and a most convenient location for docks and other accessories to navigation where their operation will not be interrupted by variations in the height of the water in the river.

As against these advantages there is the cost of maintaining and operating the locks and their accessories. These, however, are not of such expensive construction, nor do they require such careful maintenance as locks in the dams built in the river proper. Also the current through the various levels being at all times uniform the traffic is under better control, and what it loses in not having the assistance of the current in one direction it more than makes up in not being obliged to move against a strong current in the opposite direction. It is hampered, however, by the inability to move at high speeds incidental to navigation in narrow channels.

Works of this kind are of the most permanent character. When properly constructed at the beginning they do not depreciate. In fact, the longer a canal bank stands the better it becomes and the less maintenance it requires. Also the artificial bank makes the best possible location for the towing path and, as the artificial channel will usually pass through agricultural lands, it becomes possible for the individual farmer to have his own loading place and handle his products at the lowest possible cost.

Dimensions of Canals

The dimensions that will be given to any canal and its accessories will depend entirely on the volume and character of the traffic that it is designed to carry and the distance it is to be moved. If there is a great bulk of low class traffic such as coal and ore, to be moved for long distances the canal should be large enough to accommodate the largest size of boats than can be economically operated provided the cost of building the canal is not excessive and the available supply of water is sufficient. If, however, the volume of traffic, though it may be large, yet is made up of a great variety of commodities or moving short distances, the canal can be made very much smaller with decided advantage as to cost of construction, maintenance and operation, and the boats that will be used will be of smaller and cheaper construction, thus enabling people of small capital to own boats and operate on the canal, making it more generally useful.

Another factor is the method of moving traffic in the canal or waterway. Is it to be moved by animal towage or mechanical towage from the banks by towing-boats or are the boats themselves to be equipped with power? The ideal canal is one where all three of these methods can be simultaneously used, but this also assumes that much of the traffic is to be moved long distances, because the towing-boats cannot be used to advantage for short distances. The economical size of boat will be the one which permits the movement of the maximum number of tons with the minimum labor. The minimum labor is probably two persons for a single boat. From the writer's experience he knows that a boat carrying 100 tons and manned by two persons is not economical in the coal carrying traffic. This same force could as easily handle a boat carrying 200 tons moved by animal towage and worked 12 hours per day without detriment to either men or animals, so that this may be considered the minimum size. The maximum size will be controlled by the greatest tonnage or cargo that can be carried per man of the crew and the economical depth that can be secured in the channel. This in the estimation of the writer will be somewhere between 7 feet and 10 feet; the beam and length of the boat will then be determined by the amount of cargo that it is desired to carry.

It is not economically sound to design a canal or river improvement that is to depend for its traffic on the products or industries within easy reaching distance for boats of large capacity. Nor is it sound to design for boats of very small capacity. The canals and river improvements made under the various internal improvement acts by the various States early in the nineteenth century, with the exception of the work on the New York State canals, were on too small a scale to be economical for permanent use, but at the time they were equal to all demands. Had they been built on a more extensive scale the cost would have been so excessive that they could not have been undertaken. They served their purpose well, and in the case of New York it has been deemed advisable to spend large sums for increasing their capacity. In the meantime, however, they have demonstrated their usefulness. In the case of the other States the canals have practically gone out of existence from various causes, the chief of which has been the failure of the people to appreciate their advantages and their consequent failure to maintain, protect and improve them. It is submitted, therefore, that in the design and construction of new canals and river improvements it is truer economy to design and build for a comparatively small capacity of boat, paying careful consideration to future enlargement after the traffic has grown sufficiently to warrant it, after the country through which it passes has developed in either agriculture or manufacture, or both, to a sufficient extent to produce traffic sufficient to warrant the expense. This is the course that has been unconsciously followed by the European canals, and also by the railroads in the United States, which now, after the generations they have been in operation, find it necessary to double track, relocate and regrade in order to increase the economy of handling their traffic. In the meantime, however, their original cost has been earned many times over, and they have demonstrated their usefulness.

In the design of new river improvements or canals, therefore, a valuable lesson may be learned from the history of railroad development. This is in no sense an argument against the development of water transportation, but it is an argument to go slow, study the question from an economic standpoint and design for present needs and the needs of the near future, letting the more distant future take care of its own problems, and make such improvements and enlargements as experience proves to be both necessary and desirable. There is no good reason why the present generation should spend money lavishly to make developments for future generations, loading them up with debt that they must pay, when there is a possibility that the work may be abandoned entirely, just as has happened in many cases with the improvements in river and canal navigation made in the early part of the nineteenth century already referred to. In some cases, no doubt, the present generation is still paying the interest and is responsible for the principal of the internal improvement

bonds, as they were called, issued to pay for "improvements" made nearly a century ago and now gone out of existence. The reason for the disappearance is immaterial.

Principles of Operating

As before stated, the design of any river or canal improvement should have in view the simultaneous use by boats of all sizes that can navigate it, no matter by what means the boats may be moved.

The historic way to move boats on canals is by animal towage, and this presupposes boats of small capacity or very slow progress, or both, and is consequently not economical; and yet it is the only means available to the individual of small means.

Little effort was made to improve the methods of towing boats from the shore until after electricity became available as a source of power. Since then a great deal of thought and a great deal of money has been expended upon the problem, but not with any great amount of commercial success. The towing can be done successfully and with great economy, but the cost of installing the necessary equipment is so great that interest and depreciation far outweigh the economies in towing. The literature on the subject of electric towing on the European canals is very voluminous, but little has been done in that direction in the United States except in the way of experiment in three cases, none of which developed a sufficient certainty of commercial success to warrant any extensive installations.

The advantage in towing boats from the shore rather than from a floating towboat is that there is little or no "slip" as compared with the screw propeller or paddlewheel, and consequently the power is used to a greater advantage. The only disadvantage, aside from the cost of installing the towing plant, is the necessity for a towing line reaching the shore; but this in practice is not serious. The requirements of the towing machine are that it must be able to operate continuously and economically at all speeds, below the maximum, down to a slow walk, because the requirements of canal navigation necessitate that the craft must be under control at all times. It must be "fool proof," because it must be operated by the cheapest possible labor. It must be cheaply constructed and not liable to breakdowns, because it will be usually far away from facilities for repair and rather difficult of access quickly, and, of course, it must be weatherproof and it must be capable of exerting its maximum power at very low speeds, because the greatest power is required in starting the boat.

It must operate on some sort of a track or permanent way. All attempts to tow boats by machines operating on the towpath or other similar road not designed to keep the machine in a predetermined path have been miserable failures. The permanent way must be cheap to install, easy to maintain and not liable to damage by water in case of overflow in times of flood. It must be possible to construct and maintain it without interfering with the maintenance of the banks of the canal, the repair of leaks and so forth, and must not prevent access to the waterway for the purpose of loading and unloading boats with a reasonable degree of economy and convenience.

It is not the purpose of this article to go into the discussion of electric towing of canal boats so we will be content with giving the specifications of the requirements and leave it with the remark that it will never be economical to install electric towing until the density of traffic on the waterway far exceeds any so far attained in the United States on any waterway.

The only other means of towing boats and avoiding the use of animal power is by the use of floating towboats. These may be of two general kinds. One a towing boat equipped with power and designed to pick up a chain or rope anchored at either end and lying in the bottom of the waterway and moving the boats by pulling against the chain. Such boats are used successfully on some European waterways, but have never been used in the United States.

The only other kind is a boat equipped with some sort of power and moving by means of a screw propeller or side wheels. Boats of this class with steam as a motive power are too common to require any attention.

Attempts have been made in an experimental way to substitute electricity conducted from a wire suspended over the waterway to the boat for steam, but it has never been commercially successful. A suggestion has been made to equip a power boat with electric machinery and conduct the current through a species of tow line to boats following it, equipped with motors and screws, but this has never been put in practice.

The most promising substitute for steam to operate towing boats is probably the internal combustion engine operated either by gasoline (petrol) or by producer gas, the latter will probably prove the most economical on account of the cost of the gasoline (petrol).

In order to satisfy himself that an internal combustion engine operated by producer gas could be used for navigation purposes the publisher of this journal, in the summer of 1910, equipped a small boat with an internal combustion engine and a suction gas producer and operated the boat experimentally during the entire year, securing some valuable information, and demonstrating that such an equipment was practicable and economical. Later several barges with a similar equipment were built at Baltimore and are now in operation successfully. In the summer of 1911 the Lehigh Coal and Navigation Company, which operates a canal in Pennsylvania, caused two towing boats to be built equipped with gas engines and suction gas producers and operated them as towing boats in its canal with a considerable degree of success. These boats were equipped with 54-inch suction gas producers to use anthracite coal and four cylinder engines that at 300 revolutions produced 70 horsepower. The propellers were 52 inches in diameter and 32 inches pitch. The average revolutions during operation were 280 per minute, so about 65 horsepower was developed under operating conditions. The hulls were 42 feet long and had 10 feet beam and drew 54 inches. The canal where they operated has a minimum width at the surface of about 60 feet, and at the bottom about 20 feet; the depth is about 6½ feet. The boats were loaded to the depth of about 63 inches. They have a beam of 10½ feet and a length of 88½ feet, and carry a cargo of about 96 tons, average, and the boats themselves weigh about 22 tons, making the weight of boat and cargo 118 tons. Attempts were made to attain a speed of 3½ miles per hour towing loaded boats with these power boats, but they were unsuccessful even with two towing boats aggregating about 130 horsepower. Tows of from 4 to 6 loaded boats, however, were successfully towed at a speed of about 2½ miles per hour under operating conditions with a single power boat. These figures illustrate clearly the tremendous expenditure of power necessary to move boats through the comparatively restricted channels of artificial navigation and the great waste of power in attempting to do so by any of the usual kinds of power towing boats.

It will be interesting by way of comparison to state that the writer in some of his own experiments towed the same boats similarly loaded on the same canal under similar conditions by an electrically operated device at a speed of 4½ miles an hour with the expenditure of about 35 horsepower, illustrating the great advantage of having a practically fixed point against which to exercise the pull and the advantage of towing from the shore over towing by floating craft.

The navigation of the narrow shallow channels of canals at high speeds makes some method of protecting the banks imperative. The damage caused by the boats moving at high

speeds does not come from the propellers of the towing boats but from the bluff bows and square sterns common to canal boats. These waves are caused directly by the speed at which the boat is moving, and the damage is done near the surface of the water where the protection must be put. This protection is most effectually and economically secured by paving on the slope of the bank, carrying the work well toward the bottom of the canal and, of course, should be placed wherever the material is of such a character that it can be damaged by the wash.

In view of the above experiences it would appear that the most serviceable canal to the public at large would, when the traffic becomes sufficiently dense to warrant the investment, be one equipped with some form of towing device traveling on the shore and towing any and all boats between all points for a charge that would be the same per ton to everybody.

A very economical method of handling traffic is to navigate canal boats in fleets, following the practice in use for many years on the Erie Canal in New York. On that canal one canal boat is equipped with a steam engine and screw propeller which, of course, takes up some of the cargo capacity. A second boat is placed immediately in front of the power boat and close to it in such a manner that the stem of the power boat bears against the stern of the forward boat, being connected so that the two boats move on each other after the manner of a hinge. A device is placed on the leading boat by which the power boat may be swung from side to side, and the steering is performed by this movement. Very little power is used to steer in this way, and the two boats can navigate easily a channel difficult to negotiate with a rudder by a single boat. The two boats move together by the power on the power boat. In addition to this couple, from two to four other boats are towed astern on hawsers, and all are moved by the one power boat. Steam is the power now employed, but if internal combustion engines with suction gas producers were substituted greater economy would be secured and certain savings in expense of operation as compared with steam could be made. This is probably the cheapest means of moving traffic on a canal, and it has the very great advantage of enabling the fleet to navigate anywhere under its own power. In practice fleets of this kind under their own power travel from Buffalo through the Erie Canal to New York harbor, and thence through Long Island Sound to New Haven, Connecticut, or through connecting waters to the Delaware and Chesapeake Bays, and could travel any waters except the open ocean or the Great Lakes, where the risk of storms would be too great.

Size and Equipment of Locks

The size of the lock chambers and the depth of water on the mitre sills will depend on the width of the boats to be passed and their maximum draft loaded. If the boats are not too large, and there is plenty or water for locking purposes, it is probably better to build the locks to pass two boats simultaneously than to pass them singly. If they are to pass in pairs the locks should be arranged so that they will lie in the chamber one behind the other. If desirable, the chamber can be divided in the middle with gates, so that if only one boat is to pass the entire lock need not be filled, and water will be economized. This arrangement is especially desirable if boats are to be operated in pairs as described above, as it will render it unnecessary to disconnect them and time will be saved.

It is difficult to improve on the arrangement of the lock gates that has been in use many years. The material of construction may vary, but scarcely the arrangement, and the operation is a simple problem in the application of power.

There is greater range for variation in the facilities for controlling the water in filling and emptying the lock. The water should not be either put in or taken out largely at a single point, as this creates currents in the chamber that make it difficult to control the boats while filling and emptying. The bye-passes should be so arranged that the water can be introduced to and withdrawn from the chamber at several points along both sides simultaneously, then it can be filled or emptied with the greatest rapidity without danger to the boats or the gates.

As the controlling valves are at all times, except when being repaired, under water and out of sight, they should be of the simplest design and most rugged construction possible, and must be either designed to be easily and rapidly removed for repairs or provision must be made for the easy construction of cofferdams to permit the repairs, as these are the portions of locks that require the greatest attention and the most repairs. Cast iron is probably the best material for use in these parts. It is sufficiently strong and is cheap and admits of being readily cast into interchangeable parts. It resists the corrosive action of the water sufficiently long, because these parts are worn out by the action of sand and other solids carried by the water long before they are damaged seriously by corrosion. The various copper alloys are equally adaptable for the purpose, but their expense is hardly warranted, as they would wear out equally as fast as the cast iron, and the expense of repairs would be much heavier.

River Improvements Already Undertaken in the United States

The most ambitious project of river improvement for navigation undertaken in the United States, and probably in the world, is, of course, the improvement of the thousand or more miles of the Mississippi River. This has been under way for several generations, and is still far from being completed. Neither can the work actually completed be considered entirely successful. The Mississippi is a stream with a very small slope to its bottom; and yet, by reason of the large volume of water it carries, the current is not slow. It carries at all times a large volume of solid matter which it deposits in the long reaches of the river where the velocity is reduced. The banks are high, of alluvial material that is easily eroded, permitting the stream at high water to change its course easily. The work of improvement has consisted almost entirely in works to prevent or reduce this erosion and to confine the current into a narrower channel so as to create a scouring velocity at points where the filling of the channel with silt created difficulties. Millions of dollars have been spent in this work, and yet a satisfactory navigable channel at all stages of water has not been secured. It seems hardly worth while to go into the details of the construction and placing of mattresses and so forth, as this has so often been described in the technical press.

Many millions of dollars have also been expended in the attempt to make a navigable depth of water in the Ohio River from Pittsburg, Pa., to Cairo, Ill., where it joins the Mississippi. Here the problem is different, the slope of the stream is greater and the volume of water very much less. There are rapids in the stream, as at Louisville, Ky., and in the reaches of the river between Cincinnati and Pittsburg, so that the work had to be differently planned and carried out than on the Mississippi. At Louisville a dam and lateral canal were constructed and a number of dams have been built in the river above Cincinnati to secure the depth necessary for navigation. The principal traffic on the Ohio River is coal from Western Pennsylvania and Eastern Ohio, which is floated down the river on immense fleets of barges and reaches market at all points along the Ohio and Mississippi rivers as far as New Orleans. The tonnage carried, however, scarcely warrants the expense of the improvements up to this time.

A number of streams flowing into the Ohio River have also been improved to some extent, but the work has not been so important.

The problem of river improvement in the United States is the most colossal that has ever been given serious consideration, and the money required for the work staggers the imagination. Not less than 30 rivers and systems ten miles and more in length discharge into the Atlantic Ocean, and these have an aggregate mileage of about 4,765 miles. At least twenty-one rivers and systems of ten miles in length and over, exclusive of the great Mississippi River system, discharge into the Gulf of Mexico, aggregating a mileage of 5,235 miles, and the Mississippi River system alone, draining as it does fully half the area of the United States, has an aggregate mileage of about 13,017 miles, making a grand total of the rivers and systems, excluding those flowing into the Great Lakes and the Pacific Ocean, of 23,017 miles. When it is remembered that a comparatively small portion of this mileage will permit of continuous navigation by vessels drawing even as little as 5 feet of water some inkling of the magnitude of the work of improvement can be obtained.

Several hundred projects looking to the improvement of disconnected portions of this vast mileage have been undertaken by the Federal Government and, in spots, a great improvement has been made. It is only within a very few years, however, that any attempt has been made to correlate these improvements so that they will mutually support and extend each other so as to make the improved streams valuable as highways for commerce.

It is not worth while to even attempt to catalogue the names of these projects that have been undertaken or are being carried on. Anybody curious in this direction can consult the River and Harbor Bill annually since it took its permanent place on the calendar of Congress, and there he will find all the projects listed, together with the amount that has been appropriated for carrying them out.

In addition to these river improvements proper some little work has been done in the direction of building canals by the Federal Government and a greater mileage, though not of as large construction, has been undertaken by the various States at their own expense.

Omitting those artificial channels between arms of the ocean that have been constructed by the Federal Government, the most important is the canalization of the St. Mary's River, connecting Lake Superior and Lake Huron. This improved waterway passes more tonnage annually than the Suez Canal, and is probably the most important artificial waterway in the world, so far as tonnage is concerned.

The Illinois and Mississippi Canal, connecting the Illinois River and the Mississippi, was also built by the Federal Government, and it, with the Illinois and Michigan Canal, built by the State of Illinois, make a continuous waterway from Lake Michigan to the Mississippi River. This canal, however, has not grown to a position of importance as a highway for commerce. Out of all the commerce originating in the very productive territory through which it passes it carried in 1910 only the paltry tonnage of 244,635 short tons, and more than half of this was tonnage of the government.

Of the canals built or being built by far the most important is the Erie Canal now being enlarged by the State of New York so as to permit the passage of barges carrying 1,000 tons. This canal extends from Buffalo to Albany, and, together with the Hudson River, makes a continuous waterway from the Great Lakes to the Atlantic Ocean.

In addition to the States of Illinois and New York already mentioned, Ohio is making some expenditures for improving its old and practically abandoned canals. During the early part of the nineteenth century, when canal building was popular, Ohio built two separate canals, connecting Lake Erie with the Ohio River. These canals were small and would only permit the passage of boats of about ten feet beam and drawing about five feet when loaded. An attempt is being made to rehabilitate these canals, but unfortunately, instead of at the same time enlarging them to permit the passage of boats of economical size, they are being rebuilt on practically the same old lines, and no effort is being made to increase their capacity.

None of the other States, or, for that matter, no corporations, are doing any work toward building canals or improving navigation facilities, and out of the several thousand miles of improved waterways and canals, built by the several States in the early part of and operated up to the middle years of the nineteenth century, scarcely 400 miles, exclusive of the Erie Canal, are in operative condition.

Dimensions to Be Given to Maritime Canals

With the rapid increase in size of ocean liners that has taken place within a very few years it is difficult to foresee just what depth and width should be given to maritime canals that are to be used by the future ocean carrier. However, there are a few general principles that will have a strong effect on the design of ships and which in turn will dictate the economic size of the canals through which they are to navigate. Canals will probably not be built for the use of the large ocean greyhounds, as they will always be used for the fast service, and the difficulty and delay incidental to the navigation of the comparatively narrow channel of a canal will make the service through them not only slow but unprofitable. Their ports will always be on large deep bays and arms of the ocean, which, though they will be improved waterways, will not in the strict sense be called canals.

The depth, and this has more controlling effect than any other dimension, of any canal will be dictated by the traffic that is expected to use it, and this in turn by the depth or draft of the vessels. The economic draft of the freighter of the future will be controlled by the depth of the channels in the ports at which it calls. The economic freighter is the one of such a size that it can go to any of the principal ports of the world, and can be used in any traffic in search of freight and can enter any of the principal ports of the world. A great number of these ports have not any great depth of channel, and it will be many years before they will be improved, and yet they are, and will for many years, be ports from which great quantities of traffic are handled. It is probable that 26 feet is the maximum draft of vessels that can enter the majority of such ports, and unless the canal be designed for the purpose of handling some particular traffic, it should be designed for a draft of vessel of about 26 feet. The draft being established, the other dimensions follow naturally and the width of the locks of the canal will be designed accordingly. Turning basins and passing points will be made to accommodate the width of vessel, the length of vessel that is indicated by the depth and curves will be designed from the same data. Vessels of this type while navigating the canal under their own power can hardly expect to make a greater speed than about two miles an hour. It is probable, however, that with an efficient means of towing the vessels from the shore a higher speed, possibly even as much as four miles per hour may be attained, but this will be only where the channel is wide enough to permit this displaced water to flow past the moving vessel with a velocity sufficiently slow to avoid running the vessel aground by the stern.

From the limitations imposed by the lack of great depth in most of the harbors of the world the "tramp" steamer will not for many years attain the size of the leviathan used in the transatlantic trade.

New French Line Steamship France

The new French liner *France,* which recently made her maiden voyage from Havre to New York, is not only the largest and speediest French merchantman, but her accommodations are more luxurious and tasteful than in all previous boats of this line. Both engines and hull have been built at the Atlantic Works, St. Nazaire. Her keel was laid April 20, 1909; she was launched Sept. 20, 1910, and left the builders' yard April 3, 1912, for her trials. She is of the following dimensions:

Length over all	715 feet 3 inches.
Length between perpendiculars	685 feet 2 inches.
Breadth	75 feet 3 inches.
Depth to the main deck "D"	52 feet 10 inches.
Depth to the upper deck "A"	78 feet 9 inches.
Draft, loaded	29 feet 6 inches.
Gross tonnage	23,000
Displacement	28,000
Cargo capacity	6,000
Shaft-horsepower	45,000
Designed service speed	23.5
Best speed on official trials	25.9

The hull is built of Siemens-Martin steel, the upper works excepted, which are made of high-tensile steel. The keel consists of three plates 2⅝ inches thick, riveted by hydraulic power. A double bottom of 2,500 tons water capacity, extending for nearly the whole length of the ship, is divided into sixteen watertight compartments. From stem to stern the vessel itself is divided into thirteen watertight compartments by transverse bulkheads, which are pierced by twenty watertight doors, operated either by hydraulic power or by hand, according to Stone Lloyd's patent. The captain, from the navigating bridge, may close or open separately all the doors or close them all at once. A loud bell is always put into action before the doors are closed from the bridge, and if anyone is locked into a compartment he may open the door by hand, which will close again after his escape. The necessary water for operating the doors is maintained in two accumulators under a pressure of 550 pounds. A Weir pump keeps the water in the accumulators under the normal pressure. In case water enters any compartment it may be discharged outside by seven powerful steam pumps, having a total capacity of 2,500 tons of water per hour.

The hull is further divided by eight steel decks, which from the bottom are named H, G, F. E, D—main deck—C, B and A at the top.

Above the "A" deck there is a deck house, containing the captain's apartments, the chart and pilot house and the navigating bridge, which is about 52 feet 6 inches above the load waterline.

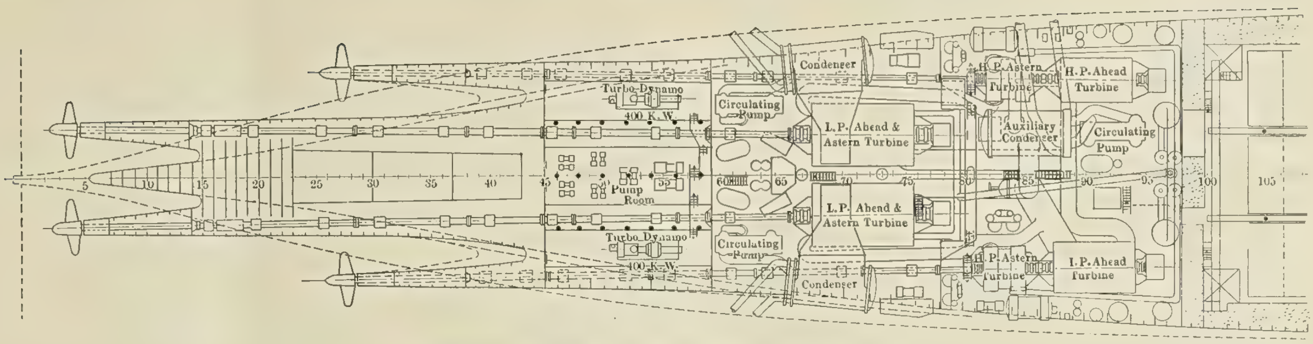
On the "A" deck there are a few lifeboats, all of the thermotank ventilators, the dog kennel, the skylights opening to the first and second class accommodations and the engine rooms.

THE FRANCE, THE LARGEST AND SPEEDIEST FRENCH MERCHANT VESSEL

On the "B" deck, or boat deck, are located in large deck houses the officers' quarters, the children's room, the gymnasium, the printing office, library, bookseller's shop, wireless office, telephone office; then about amidships are the first class social hall, the monumental entrance to the first class accommodations, and towards the stern are the *"salon mixte,"* the smoking room and the open café. All these different rooms are conected by a splendid gallery.

Forward on the "C" deck there is an observation room, and on both sides for about 90 feet in length there are thick panels of glass, which give a good shelter for the passengers and enable them to have a good view over the sea in spite of bad weather. This deck is used as a promenade deck by the first class passengers. It is devoted to the "apartments de luxe" and to the first class cabins. Near the main staircase there is the flower shop. Aft is the entrance to the second class accommodations, and the after end of this deck is at the disposal of the second class passengers. Forward and aft are the winches, capstans, etc., for maneuvering purposes as well as for handling the cargo.

Both ends of the "D" deck, or main deck, are reserved for the crew, third class and steerage passengers. Amidships it is divided into numerous first and second class staterooms, to-



MACHINERY SPACE OF THE FRANCE (*From Le Yacht*).

gether with the postoffice, ladies' hair dressing room, information office; aft, there is the second class smoking room.

The "E" deck—the first 'tween deck—is almost entirely devoted to the first and second class passenger accommodations; forward there are the crew's quarters, together with third class staterooms, also the hospital and infirmary.

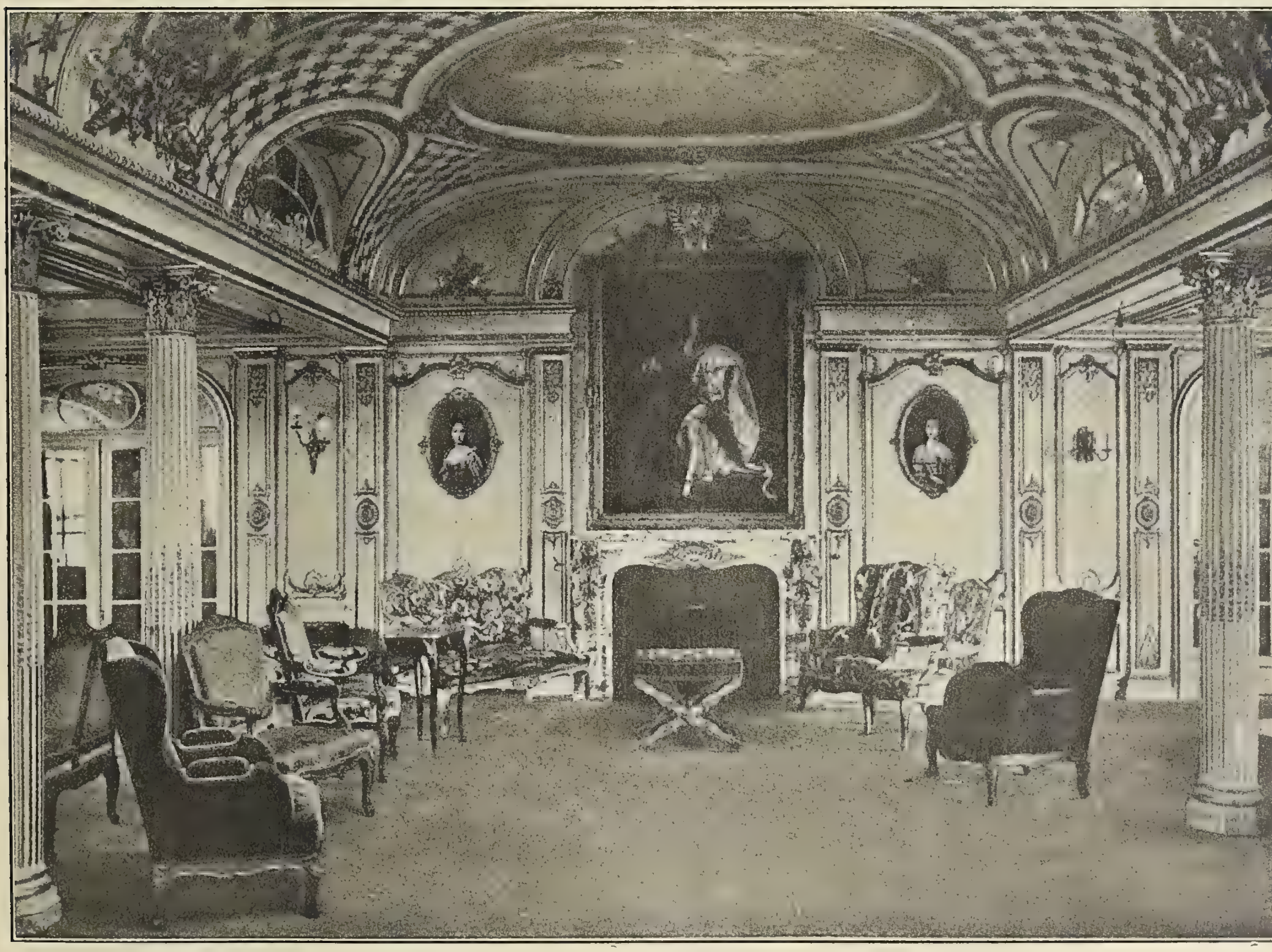
Forward on the "F" deck are the crew and steerage passengers' quarters. Amidships is the first class dining room, extending two decks in height; abaft of the same is the galley and its accessories, then comes the engineers' quarters alongside the engine room casings; aft are the second class dining room and staterooms.

The "G" deck, or third 'tween deck, is devoted, forward and aft, to the steerage passengers, and in the central part of the ship to the firemen, stewards and stewardesses.

The fourth 'tween deck, or "H" deck, is occupied chiefly by cargo and bunker space; there are also large storerooms, refrigerating rooms for meat, fish, vegetables, game, etc., passenger luggage rooms, etc. Down below, on top of the water ballast tanks, are the boiler, engine and dynamo rooms, the bunkers and cargo holds.

Referring to the accommodations, all the social halls are in connection with a large gallery. Neither sculpture nor golden decorations have been used there; the panels are made of thin wooden lattice work. Evergreens and flowers are in profusion, and the whole arrangement very much resembles a winter garden. It is lighted by numerous electric lamps and large bow-windows.

The first class drawing room is of the finest Louis XIV. period. Owing to its dimensions, selected with care, it gives an ideal relief to the furniture. All of the decorations are carried out in pleasing harmony. Excellent pictures are used in decorating the ceiling and the panels. Among others there are paintings of Louis XIV., a Return from Hunting at



FIRST CLASS DRAWING ROOM ON THE FRANCE. DECORATIONS OF THE FINEST LOUIS XIV PERIOD

Vendôme Castle, the portraits of Margaret of Burgundy, Miss de la Vallière, Duchess of Aoste, Anna of Scotland, etc.

The *"salon mixte"* is of the "Renaissance" period; it is to be used both as a writing and music room. The smoking room is of a fancy Turkish style, and with its white marble fountain has a very unique appearance. The coffee house is of carved oak; the open café of lattice work, resembling a garden. The children's dining room is paneled with carved wood, with several medallions representing child scenes from La Fontaine's stories.

The entrance to the first class accommodations is a monumental one. First, there is a bronze statue of France, set in a recess of red marble. A dome of forged iron with stained glass is placed above the staircase. The first class dining room is situated on the "F" deck; the panels are decorated with a frieze representing a hunting scene. A monumental staircase of forged iron connects the two floors of this room. On the panel of the staircase is a painting showing a scene of the Versailles gardens at the time of Louis XIV. This dining room, extending the whole width of the ship and two decks in height, is large enough to accommodate 375 persons at the same time; all tables arranged for from two to seven persons.

CARVED WOOD PANELS IN THE "APARTMENTS DE GRAND LUXE"
MARBLE FOUNTAIN IN THE MOORISH SMOKING ROOM
STATUE OF FRANCE, BY NELSON, AT THE FIRST CLASS ENTRANCE

There are four "apartments de grand luxe," each consisting of a bedroom, a drawing room, a dining room and a bath room. One is of the Louis XIV. period, one of the Empire, and others of the Directoire style. The panels are of carved wood, marvelous pieces of cabinet work, indicative of the sumptuousness of a prince's palace or castle.

The first class staterooms have been erected according to the drawings obtained in a concourse established by the owners. Fifty-three staterooms for two passengers have been built according to the drawings of Mr. Truck; the panels are of lemon wood, with a frieze of fibro-cement, and they are of very graceful appearance. Fifty-four other two-passenger staterooms have been built according to Mr. Laffilée's designs; they are of fibro-cement panels with "bageuttes" of lemon wood. Sixty staterooms for one passenger have been decorated by Mr. Adams in the English modern style; the panels are of olive wood. These cabins are designed for comfort, and are so arranged that they can be transformed into two-passenger staterooms by especially designed doors. There are sixty staterooms which have been designed by the "Atlantic Works"; they are for four, two or three passengers, the panels being of lemon and rose woods. All of the "apartments de luxe" are equipped with telephones.

The accommodations for the second class passengers are, of course, not so elaborate, but they offer the same comfort. There are 126 second class staterooms, with four or six berths; the panels are of mahogany wood, as is also the furniture.

The heating and ventilation of all apartments is electrically operated, and each passenger may regulate at will the temperature of his own stateroom. All dining rooms, smoking rooms, etc., are automatically heated and ventilated. When the temperature is at a certain minimum or maximum the fans are automatically set at work, either for cooling or heating the air delivered into the accommodations.

There are two electric elevators at the disposal of the first class passengers, going through four decks; a single elevator, running through three decks, is to be used by the second class passengers. Four hundred electric clocks are distributed throughout the ship. There is one clock in each first class stateroom. They are all regulated by the chief officer from the navigating bridge.

Below the lower deck, as already stated, nearly the full length of the ship is occupied by the machinery space, viz.: 279 feet by the boiler rooms and 148 feet by the engine rooms.

There are twenty cylindrical marine boilers, either single or double-ended, made of semi-hard steel, designed to work under a pressure of 200 pounds per square inch. There are four boiler rooms, each having its own funnel, extending 112 feet above the grate bars, of elliptical section with diameters 13 feet 6 inches and 17 feet 5 inches. The total number of furnaces is 120; the grate surface aggregating 2,600 square feet and the heating surface to 101,100 square feet (ratio 1/38). The boilers are operated by the Howden forced draft system, which is maintained by electrically-driven fans. The ship carries 5,000 tons of coal in her bunkers for a single trip.

The four propellers are driven by four lines of shafting, each transmitting about the same power. The main turbines consist of one high-pressure, one intermediate-pressure and two low-pressure ahead turbines, and two high-pressure and two low-pressure astern turbines. The engine room is divided into three main compartments, the first two containing the main turbines. In the first is located the high-pressure and medium-pressure turbines driving the wing shafts and the auxiliaries and the auxiliary condenser. In the forward part of the engine room is the starting platform, connected with the ahead and astern turbines, and from which all turbines may be controlled. The starting platform is connected by telemotors, telephones and telegraphs with the navigating bridge. In the second engine room are the low-pressure turbines and the main condensers, together with their auxiliaries. In the forward part of this room is a small starting platform acting on the inner shafts only when used for maneuvering purposes. Under full load, at 240 revolutions per minute, the shaft-horsepower developed was over 45,000, and the speed obtained 25.9 knots.

Turbine casings are of cast iron, the rotors of fluid compressed steel, as well as the disks; they have been machined

out of ingots. The blading has been made according to Parsons' latest design, with the usual method of binding. The shafts are made from steel ingots. The bearings work under forced lubrication. The high-pressure turbine alone weighs 120 tons, the medium-pressure 115 tons, each of the low-pressure turbines 250 tons and the shafting about 150 tons.

The four bronze propellers of the four-bladed type are 13 feet 2 inches in diameter. The two main condensers have a surface if 43,000 square feet.

The auxiliaries of the main engines are in duplicate in order to meet the needs of such powerful machinery even if one of the compartments should be flooded.

The electric plant consists of four 220-volt dynamos operated by steam turbines, and supplies current for about 6,000 lamps and for the forced draft and ventilating fans, and also for the electric elevators, boat winches, cargo winches, capstans, etc. The refrigerating plant, consisting of two machines, has been so designed as to maintain a temperature of 5 degrees C. in the cold chambers.

One of the most interesting parts of the ship is the chart room and the navigating bridge. It may be called the brains of the liner. In a large bridge house are located the compass, the German hydro-electric steering gear, the Stone Lloyd's maneuvering gear for the ship's watertight doors, and a plan giving the exact position of the twenty doors, showing whether they are closed or open. Owing to the long distance between the bridge and the starting platform in the engine rooms, special telegraphs have been used: First, ordinary telegraphs of large size and in duplicate, then special telegraphs. When an order is given from the bridge an electric lamp is lighted, and then cut off when the engineer has answered the order. This telegraph, which is practically like that used in naval vessels, is in duplicate, both for the main engines as well as for the low-pressure turbines driving the inner shafts, and is used for maneuvering purposes. A similar telegraph is used for transmitting orders to the after navigating bridge.

There are twenty lifeboats, 30 feet by 8 feet 3 inches, each with a capacity for fifty-two persons, besides a whale boat and a dinghy.

The crew consists of sixty deck hands, 260 engine hands and 275 stewards, pursers, stewardesses, etc. The accommodations have been designed for 550 first, 450 second, 250 third and 800 steerage passengers.

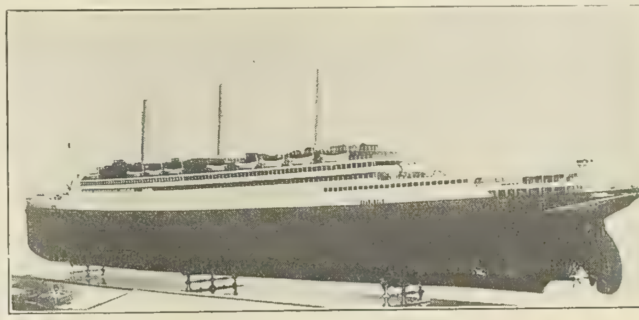
The French Trans-Atlantic Company has just ordered another still larger liner, 821 feet in length, to be built in the same yard, but the order is subject to improvements to be carried out in St. Nazaire harbor, so as to enable the launching and drydocking of this new ship. At present the St. Nazaire drydock could not take in a ship of that length, but this matter will shortly be settled and the building started.

It is also practically certain that further improvements will be made in the river Loire, where a channel 2,600 feet in width, extending several miles in length, will be dredged to a depth of 45 feet, therefore enabling large ships to enter or leave at any time without the necessity of locks. The matter is pending before the Public Works for approval.

The United States battleship *Texas* was launched May 18 by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. With all stores aboard the vessel will displace 28,367 tons. The dimensions are 573 feet length and 95 feet 2½ inches beam. The draft will be 28 feet 6 inches, and the speed 21 knots. This will be the first ship in the world to carry 14-inch guns, of which there will be ten, in addition to which there will be twenty-one 5-inch rifles. The vessel will be propelled by twin-screw triple-expansion engines of the old type, developing 27,000 horsepower. The fourteen watertube boilers will be fitted for burning either coal or oil.

Launch of the Imperator

The Hamburg-American Line steamship *Imperator* of 50,000 tons was launched May 22 at the yards of the Vulcan Shipbuilding Company, Hamburg. This vessel is the largest ship afloat. Her length is about 900 feet and her beam 96



MODEL OF THE IMPERATOR

feet. Her engines are designed to develop 70,000 horsepower, giving the vessel an average speed of 22½ knots. The photograph shown herewith is a view of a 20-foot model of this ship.

Important Notice

Engineers, steam fitters, contractors and users of valves and fittings are notified by members of the Manufacturers' Standardization Committee that it would be inadvisable to specify or order flanged fittings to the so-called 1912 United States standard for standard weight and extra heavy flanges and flanged fittings as adopted by the National Association of Master Steam and Hot Water Fitters, because this standard has not been accepted as final by the manufacturers of flanged fittings and valves, and will not be accepted until certain necessary revisions have been made to suit the practical requirements of all concerned. Although it is not generally understood, there has been for some time a manufacturers' standard for flanges and flanged fittings which has been adopted by the leading manufacturers. This standard is the result of many years of experience on the part of the manufacturers, engineers and large consumers. Therefore, any standard which would replace the existing one should necessarily make as few changes as possible and then only where experience has proved the change absolutely necessary. This committee has already compiled a proposed standard bearing in mind all the considerations above mentioned. Therefore it is deemed advisable to maintain for the present the old practice until a universal standard can be agreed upon.

At a public meeting, May 9, under the auspices of the American Museum of Safety, New York, Mr. Axel Welin, of London, read a paper on boat installations and other life-saving devices for safety at sea. The paper was devoted almost entirely to a description of the Welin davit and the methods of stowing lifeboats and the tackle for handling boats, showing the development from crude methods to modern scientific apparatus.

Orders were received at the United States Navy Department on May 18 for the scout cruiser *Birmingham* to steam to the regions where dangerous ice floes and ice bergs menace North Atlantic travel and remain there on patrol until further orders. Wireless reports will be received from this ship twice a day at the Navy Department, and they will be transmitted through the Hydrographic Office to the steamship companies using this route.

Old American Coasting and Sound Steamers—Part III

BY FRANCIS B. C. BRADLEE

The first line of Southern steamers from Boston was the Boston & Philadelphia Steamship Company, which started in 1852 with two steamers called the *Palmetto* and *City of New York.* The Merchants & Miners' Transportation Company, running to Baltimore, began operations in 1854 with two wooden side-wheel steamers built in Baltimore, the *Joseph Whitney* and the *William Jenkins.* The former was 208 feet by 33 feet by 17 feet, with a beam engine, cylinder 52 inches in diameter by 11 feet stroke; the latter measured 205 feet by 31 feet by 11 feet, and also had a beam engine with a 56-inch cylinder 9 feet stroke. These two boats were supplemented in 1859 by two others of the same type, but slightly larger and constructed of iron, being among the first American iron sea-going steamers. They were the *Benjamin de Ford* and *S. R. Spaulding,* and were built by Harlan & Hollingsworth, at Wilmington, Del. They were used as transports during the Civil War, and afterwards were sold and re-named *San Salvador* and *San Jacinto,* and ran for many years from New York to Savannah.

STEAMER GEORGIA, 1849. NEW YORK AND CHAGRES (CAL.) ROUTE. (FROM A LITHOGRAPH IN THE AUTHOR'S POSSESSION)

After the war the Merchants & Miners' Line added many screw steamers to its fleet, among them the *George Appold,* built of wood at Philadelphia in 1864, 223 feet by 35 feet by 24 feet, with a direct-acting engine having a 56-inch cylinder by 42-inch stroke, and the *William Lawrence,* built of iron in 1869 by the Atlantic Works at East Boston (she is believed to be the first iron steamer of large size constructed in Boston), 230 feet by 35 feet by 28 feet. To-day this line has one of the largest fleets in the United States. The Boston & Philadelphia Steamship Company was absorbed by it a few years ago.

The "outside" line between Boston and New York (Metropolitan Steamship Company) was begun in 1866 with three wooden propeller steamers that had previously been employed on Long Island Sound. These were the *Glaucus, Nereus* and *Neptune,* all alike, measuring 240 feet by 40 feet by 17 feet, and having simple condensing engines, each with two cylinders 44 inches in diameter by 36 inches stroke. This line has always devoted most of its attention to freight, although in the last two or three years they have run in the summer months the fast turbine passenger steamers *Harvard* and *Yale.*

Previous to the war of the Rebellion the water transportation business between Savannah and Boston was by sailing vessels, regular lines of packets, for freighting purposes mainly, running between this and other Southern ports and Boston. In 1869 F. W. Nickerson & Company, of Boston, established a steamship line on this route. Their first vessel, the *Oriental,* was an iron screw steamer of 800 tons burden. The *Oriental* made the round trip in twenty days. The *Alhambra,* a steamer of 700 tons, was added. Finally, in 1881, the Boston & Savannah Steamship Company was organized, and they bought from the Ocean Steamship Company two iron screw steamers, the *Gate City* and *City of Columbus* (first of the name). The former was 2,000 tons gross, 254 feet by 38 feet by 15 feet, with inverted two-cylinder compound engines, the hull and machinery being constructed by John Roach & Sons, at Chester, Pa., in 1878. The *City of Columbus* was wrecked with great loss of life near Gay Head, Martha's Vineyard, in January, 1884, and soon after this the line was bought out by the Ocean Steamship Company, who continue it to this day, adding one fine steamer after another to their fleet.

The first coastwise steamer worthy of the name hailing from New York was the *Robert Fulton.* Morrison, in his "History of American Steam Navigation," says: "She was built in 1819 by Henry Eckford for Dunham & Company to run between New York and New Orleans, stopping on the way at Charleston and Havana.

"The *Robert Fulton* was 700 tons burden, 158 feet long, 33 feet beam, 15 feet depth of hold; the paddle-wheels were 24 feet in diameter. The motive power consisted of a 'cross-head' engine built by the Allaire Works, and having a cylinder 44 inches in diameter by 5 feet stroke. The connecting rods operated cog-wheel cranks on the water-wheel shafts, gearing

into cog-wheels on a flywheel shaft, the wheels running on each side of the cylinder. The boilers were of copper, placed forward of the engine, with two smoke chimneys placed side by side in front of the gallows frame."

The *Robert Fulton* may be considered as one of the world's earliest seagoing steamers. She ran regularly between New York and New Orleans, via Charleston and Havana, from April, 1820 (the date of her first voyage), until 1825, when, the financial results obtained becoming indifferent, she was sold to the Brazilian Government and her machinery removed. Her usual time was as follows: New York to Charleston, 4 days; Charleston to Havana, 4 days; Havana to New Orleans, 3 days.

ATLANTIC COAST STEAMER QUAKER CITY, 1854. (FROM A LITHOGRAPH IN THE AUTHOR'S POSSESSION)

After the *Robert Fulton* there were no Southern coastwise steamers until 1832, when a concern called the Southern Steam Packet Company was organized in New York, and ran several small steamboats called the *David Brown, William Gibbons, Home*, etc., to Charleston, S. C. These boats were built on the plan of the Long Island Sound steamers, and were unfitted to meet very heavy weather, the *William Gibbons* and the *Home* being lost near Cape Hatteras with great loss of life. These disasters threw a damper over "deep-water" steam navigation, so that for several years there were no coastwise steamers running out of New York.

In 1845, Spofford, Tileston & Company, of New York, merchants largely engaged in the Southern trade, had built by William H. Brown, of New York, a steamer called the *Southerner*, a wooden paddle-wheeler, to ply between New York and Charleston. She was about 950 tons, 191 feet long, 30 feet beam and 14 feet depth of hold, having a side lever engine with one cylinder 67 inches in diameter by 8 feet stroke. The *Southerner* was followed by several steamers of slightly increased dimensions called the *Marion, Northerner* and *James Adger*.

Prior to the breaking out of the Civil War the best-known and largest of the Charleston line steamers was the wooden side-wheeler *Nashville*, built by William Collyer at New York in 1853. She was considered at that time the fastest coastwise steamer, and made one or more trips between New York and Liverpool on the Collins Line in 1855. This steamer measured 1,220 tons gross, 215 feet by 34 feet by 21 feet, with a side-lever engine having one cylinder 86 inches in diameter by 8 feet stroke. The *Nashville* was seized at Charleston by the Confederate authorities soon after the fall of Fort Sumter.

She then remained idle until it was decided that she should take Messrs. Mason and Slidell on the first stage of their journey to Europe. When this intention was revoked, she was sent out under the command of Lieut. Robert B. Pegram, to make what might be called "a voyage of announcement" of a Confederate man-of-war to England. Her armament consisted of only two 12-pounder brass guns. On Nov. 19, 1861, when nearing the English channel the *Nashville* captured and burnt the ship *Harvey Birch*, of New York, homeward bound from Havre. The news of this event created great excitement in the North. After a stay of some length in England the *Nashville* returned to Beaufort, N. C. She then made one or two very successful blockade running trips, and was refitting in the Ogechee River (Georgia) in February, 1863, for a second cruise to Europe when she grounded near Fort McAllister, and the next day was attacked and burnt by the United States monitor *Montauk*.

After the Civil War the New York & Charleston Steamship Company operated three steamers called the *Champion, Manhattan* and *Charleston*. The former was an iron side-wheel boat (one of the early examples of American iron shipbuilding), built by Harlan & Hollingsworth in 1859 for Commodore Vanderbilt's line of steamers to the Isthmus. She was 1,850 tons gross, 242 feet by 35 feet by 26 feet, with two vertical beam engines, having cylinders 42 inches in diameter by 10 feet stroke; paddle-wheels 30 feet in diameter. The *Manhattan* and *Charleston* were wooden side-wheelers somewhat smaller than the *Champion*.

NEW YORK AND CHARLESTON LINE STEAMER NASHVILLE, OF 1853. AFTERWARDS A CONFEDERATE PRIVATEER. (FROM A LITHOGRAPH IN THE AUTHOR'S COLLECTION)

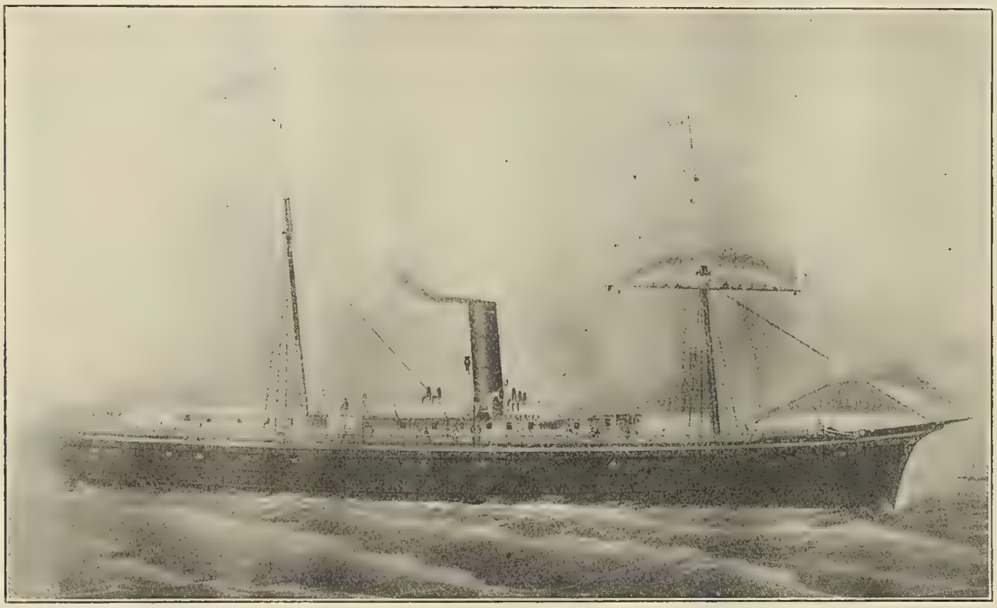
Steam communication between New York and Savannah

was begun in 1848 by the New York & Savannah Steamship Company, who ran for a short time two wooden paddle-wheelers called the *Cherokee* and *Tennessee*. They were about 1,250 tons each. The former was sold to the Law Line of Chagres and Havana packets, and burned at her dock at New York in 1853, and the latter was sold to the Pacific Mail Steamship Company and lost near San Francisco, also in 1853. After this various steamers ran to Savannah for shorter or longer periods, the best known of which was the wooden propeller *R. R. Cuyler*, built in 1859, 235 feet by 32 feet by 16½ feet, fitted with an inverted direct-acting engine having a cylinder 70 inches in diameter by 48 inches stroke.

After the Civil War, Livingston, Fox & Company, of New York, who owned four wooden side-wheelers, the *Rapidan, Raleigh, Albermarle* and *Hatteras*, all alike, each being 800 tons, 180 feet by 33 feet by 19 feet, with vertical beam engines, having a 44-inch cylinder by 11 feet stroke, engaged in the Savannah trade. An opposition line was run by Murray, Ferris & Company, with two small, box-like, "sawed off" wooden propellers, the *Leo* and *Cleopatra*. Both before and after the Civil War the Southern lines of steamers had, in proportion, a much larger passenger business than they do to-day, for in those early days the Southern railroads had not good reputations for rapidity or comfort, and after the war most of them were for some time in an extremely demoralized condition. About 1871 the various Savannah steamship interests were amalgamated into one company, now the well-known Ocean Steamship Company. They used the old boats for a while, and afterwards added such fine ships as the iron propellers *City of Macon*, first of the name (1877), *City of Augusta* (1880), etc.

Another well-known steamer of the early days that acquired quite a reputation for high speed was the *Quaker City*. She was built of wood by Vaughan & Lynn at Philadelphia in 1854, and was 1,428 tons gross, 240 feet by 36 feet by 21 feet, with one side-lever engine having a cylinder 88 inches diameter by 8 feet stroke. This vessel was employed in many and various trades, at first between Philadelphia and Charleston, then she was chartered by the Collins Line after the loss of the *Arctic* and *Pacific*, and made a number of voyages between Liverpool and New York. Just before the Civil War the *Quaker City* was running to Havana from New York; then she was bought by the United States Government and used as a man-of-war in the blockade of the Southern coast. After the war she was employed for a time between New York and Bremen on the North American Lloyds line, and in 1867 she was chartered to take a party of excursionists to the Holy Land and Europe. Mark Twain was one of the party, and the "Innocents Abroad" was partially written on board the *Quaker City*.

What was known as the "Law Line" of steamers between New York and Chagres (owned by Law, Roberts & Company), was started in 1849. This enterprise was given a great impetus by the discoverey of gold in California, from the fact that there was then no trans-continental railroad, and the route via the Isthmus was the shortest way of communication between the Eastern States and the Pacific Coast. They also had a contract amounting to $290,000 (£59,600) a year from the United States Government for the carriage of mails. When the grand rush for California took place the most exorbitant rates of passage were charged, at one time being as high as $600 (£123) first class and $300 (£62) steerage.



BOSTON-BALTIMORE STEAMER GEO. APPOLD, 1864. (FROM A LITHOGRAPH IN THE AUTHOR'S COLLECTION)

The first two vessels of the Law Line were the *Ohio* and *Georgia*, built of wood at New York in 1849 by J. Simonson and Smith & Dimon, respectively. The *Ohio* was 2,397 tons gross, 248 feet by 45½ feet by 24½ feet, the *Georgia* being 2,695 tons gross, 255 feet by 49 feet by 25½ feet. The engines of both steamers were exactly alike, of the side-lever type, constructed by T. F. Secor & Company, New York. Each engine had two cylinders, each 90 inches in diameter by 8 feet stroke. There were four iron boilers, two forward and two abaft the engines. The average speed of these vessels in good weather was 12 knots.

The largest and best known of the Law Line boats was the *Illinois*, constructed in 1851 by Smith & Dimon. She measured 267 feet by 40 feet by 31 feet, and her machinery was of a then novel type to American engineers, and one that somehow never recommended itself to them. It was built by the Allaire Works, New York, and consisted of two oscillating cylinders, each 85 inches in diameter by 9 feet stroke; diameter of the paddle-wheels 33½ feet. The *Illinois* had four iron return tubular boilers and her maximum speed was 13½ knots. On one occasion she ran from Chagres to New York, 1,980 miles, in 6 days 16 hours, being an average of nearly 12½ knots during the whole voyage. The *Illinois* was broken up at New York in 1862. One clause in the United States mail contract with the Law Line read that their vessels should be commanded by lieutenants in the United States navy, and it is

interesting to note that the captain of the *Georgia* was for several years David D. Porter, afterwards admiral of the United States navy.

These steamers connected on the Pacific side with the ships of the Pacific Mail Steamship Company (then just started), consisting of the *Golden Gate, John L. Stevens, Tennessee, Oregon, California*, etc., all wooden side-wheelers. The *Golden Gate* and *John L. Stevens* were the largest of these vessels, the former was 2,030 tons gross, 265 feet by 40 feet by 22 feet; the latter being 2,450 tons gross, 280 feet by 40 feet by 26 feet. The machinery for both steamers was exactly alike, each set consisting of two oscillating cylinders 85 inches in diameter by 9 feet stroke.

The Pacific Mail Company had a hard time at first. Their steamers found nothing ready to receive them on the Pacific Coast. The company was compelled to construct large workshops and foundries for their repair, and had also to build their own dry dock, that of the Government at Mare Island not being ready until 1854.

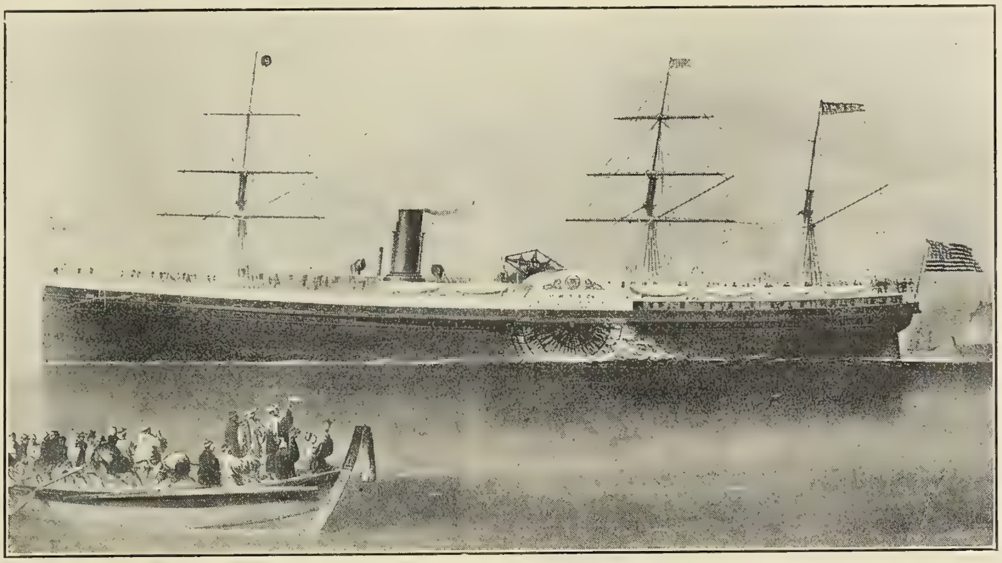
For a large portion of the early time the company had to pay $30 (£6 5s.) per ton for coal, and once as high as $50 (£10 8s. 4d.). During the late 50's there was great competition on the New York and Chagres line, Commodore Vanderbilt running several of his steamers, the *Champion, North Star, Northern Light, Ariel*, etc., in opposition to the Law or United States Mail Line. At this period also took place one of the most awful maritime disasters that ever occurred, and that was the loss of the *Central America* ex *Geo. Law*, belonging to the Law Line. She foundered during a severe gale, Sept. 12, 1857, while on her way to New York via Havana. About 423 persons were lost, and the general opinion at the time was that the *Central America* was not in a seaworthy condition.

Later on the Pacific Mail Company gained control of the traffic on the Atlantic as well as the Pacific side. In the late 60's and early 70's the following steamers ran on the Atlantic side: *Henry Chauncey, Montana, Arizona, Atlantic, Baltic* (ex-Collins liners), etc., and on the Pacific line the *Constitution, Golden City, Colorado, Golden Age* (formerly built to run from New York to Australia), etc. All these ships were large wooden side-wheelers, most of them being over 3,000 tons and over 300 feet long, and all except the *Atlantic* and *Baltic* had vertical beam engines of large power. It is said that when these large side-wheelers were heavily loaded at the beginning of their voyage their wheels were so deeply immersed that the ship would not make over 8 knots.

The first line of direct steamers to New Orleans was started by Livingston, Crocheron & Co. in 1854, with the wooden paddle-wheelers *Black Warrior* and *Cahawba*. They were built in New York, 225 feet long, with the usual vertical beam engines. The *Black Warrior* went ashore on Rockaway Bar, L. I., in February, 1859, and became a total loss. To take her place the company built more ships of the same type but larger—the *De Soto* and *Bienville*. They were in the Government service during the Civil War. After the war the best-known New Orleans line of steamers was what was called the Star Line, running the *Evening Star, Morning Star, Guiding Star* and *Rising Star*, large wooden side-wheelers about 270 feet long, with beam engines. One curious fact about these vessels was that, with the exception of the *Rising Star*, their engines had all been in use previously in steamers on the Great Lakes. The *Evening Star* foundered in a cyclone off Tybee Island with great loss of life Oct. 3, 1866.

The New York & Virginia Steamship Company was the predecessor of the present Old Dominion Line running to Norfolk and Richmond, Va. Their first ships were the *Jamestown* and *Roanoke*, wooden paddle-wheelers, built in 1851, each 1,070 tons gross, 218 feet by 32 feet by 16 feet, with double beam engines, having two cylinders each 42 inches in diameter by 10 feet stroke. In 1858 a larger ship, the *Yorktown*, was added. At the outbreak of the Civil War the above vessel and the *Jamestown* were seized by the Confederate authorities, transformed into gunboats, being re-named *Patrick Henry* and *Jefferson*, respectively. They took part in the *Monitor-Merrimac* combat, and the *Patrick Henry* was afterwards anchored in the James River below Richmond and turned into a school ship for Confederate naval officers. At the evacuation of Richmond she was blown up.

The *Roanoke* escaped seizure and continued in service in the North, but curiously enough was also eventually destroyed by the Confederates. In 1864 she was running as a mail steamer between New York and Havana, and on Sept. 29, while on her passage from the latter port, she was seized by Lieutenant John C. Braine and a party of men belonging to the Confederate navy who had come on board as passengers at Havana. The regular crew and passengers were then transferred to a passing sailing vessel, and on Oct. 9 the *Roanoke* was burned off Bermuda by the Confederates.



PACIFIC MAIL STEAMSHIP COMPANY'S GREAT REPUBLIC (1866), THE LARGEST WOODEN OCEAN STEAMER EVER BUILT

Launch of the Chinese Cruiser Fei Hung

The Chinese cruiser *Fei Hung* was launched at the yard of the New York Shipbuilding Company, Camden, N. J., on May 4. This ship, designed as a training ship for Chinese officers and men, is in reality a protected cruiser of the following principal dimensions:

Length between perpendiculars.....	320 feet.
Breadth, molded	39 feet.
Depth, molded	22 feet 6 inches.
Mean draft	14 feet.
Displacement (about)	2,600 tons.
Speed (about).....................	20 knots.

The hull is divided into numerous compartments by water-tight bulkheads and flats. A double bottom extends throughout the machinery space, in which stowage is provided for feed-water for the boilers.

The armament consists of two 6-inch rapid-fire guns, located, respectively, on the forecastle and the poop decks; four 4-inch rapid-fire guns on the upper deck at the sides (two just abaft the forecastle and two just forward of the poop); two 3-inch rapid-fire guns, on each side of the upper deck amidships; six 3-pounder guns, three carried on each side of the upper deck; two 1-pounder guns, located on the after end of the forecastle deck, and two 18-inch revolving torpedo tubes placed on the upper deck aft of amidships.

The vital parts of the vessel are protected by an armored deck of the arched type, fitted in the vicinity of the waterline and extending throughout the entire length of the vessel. The coal bunkers are so arranged along the sides of the vessel, both above and below the protective deck, as to give a maximum protection from gunfire. The ammunition for the large guns is taken through armored tubes on its way to the guns, and an armored conning tower is built on the forecastle deck, while an armored tube protects the gear rods, etc., passing from the conning tower to under the protective deck. The searchlight platform and navigating bridge are located over the after end of the forecastle bridge. A searchlight platform is also fitted over the fore end of the poop. The 6-inch guns are served by electrically-operated ammunition hoists. The two masts are made suitable for taking a wireless telegraph installation of 200 miles range.

Accommodation is provided for a complement of 232 officers and men. A large forecastle and poop are built above the upper deck at the ends of the vessel, which provide accommodation for the petty and warrant officers, etc., aft, and for the captain and chief officers forward. Under the upper deck forward and aft accommodation is provided for the crew. The galleys are placed in the casings on the upper deck amidships, and the steam and other boats are carried on skid beams and in davits along the sides of the upper deck. Under the protective deck forward and aft are placed the magazines, shell rooms, storerooms, fresh water, fuel oil, etc. Cold storage for the preserving of meats, vegetables and fish is placed above the protective deck amidships. The ship is lighted throughout by electricity.

The propelling machinery is of the Parsons turbine type, with three lines of shafting. The turbines are arranged in one engine room, as follows: Center shaft, one main high-pressure turbine with extra stage for cruising purposes; starboard shaft, one low-pressure turbine, one backing turbine; port shaft, one low-pressure turbine, one backing turbine. The astern turbines are fitted in the same casings as the low-pressure turbines. By-pass valves are fitted around the first expansion of the high-pressure for cruising purposes. All the turbine bearings and shaft bearings are arranged for forced lubrication, pumps being supplied for this purpose, together with an oil cooler and tanks, etc. The shafting throughout is of forged steel. The propellers are three-bladed, the bosses and blades being cast solid of manganese bronze; the center and starboard propellers turn right-handed and the port turns left-handed.

There are two condensers—one in each wing of the ship. They are cylindrical in form, with the castings built up of steel plates and angles. The circulating water is supplied by two pumps of the centrifugal type, driven by independent single-cylinder engines; these pumps are also arranged to draw from the bilges. The main air pumps are independent, direct acting, two in number, one for each condenser.

The two evaporators have a combined nominal capacity of 9,000 gallons of water per twenty-four hours for boilers and of 6,000 gallons of additional water in twenty-four hours. The two distillers have a combined nominal capacity of 6,000 gallons of water per twenty-four hours. The evaporators take steam from the main steam pipe, and the steam-head drain pipes lead through, and by-pass, automatic traps, to the feed tanks and main condensers. The shells of the evaporators have connections for directing the steam into the distillers and into the auxiliary exhaust pipe. The feed-water for the evaporators is taken from the circulating pipes, after it has passed through the distillers, and from the sea.

There are three boilers of the Thornycroft watertube express type located in two fire-rooms—two in the after and one in the forward fire-room. The latter is fitted for burning oil as well as coal. The water drums for these boilers were built by the Continental Iron Works, Brooklyn. The total heating surface is about 14,500 square feet, and the total grate surface about 271 square feet. Air is supplied to the fire by three blowers especially provided for that purpose. These blowers are of the Sirocco type, designed and built by the American Blower Company, Detroit, Mich., and are driven by Terry steam turbines, built by the Terry Steam Turbine Company, Hartford, Conn. These sets run at a speed of 1,220 revolutions per minute, and are supplied with steam from 150 to 225 pounds, discharging against a back pressure of from 5 to 10 pounds. Each set is capable of supplying 30,0c0 cubic feet of free air per minute against a static head of 3 inches of water.

The oil firing system for this vessel was furnished by the Schutte & Köerting Company, Philadelphia, as were also the feed-water heaters. All of the relief valves were supplied by the American Steam Gauge & Valve Manufacturing Company, Boston. The plumbing is by A. B. Sands & Son Company, New York.

It is estimated that $20,000,000 (£4,100,000) will be expended in the next five years for the development of the harbor of Seattle, Wash. In addition to extensive terminals now installed by six transcontinental railroads in this city, the Seattle Port District, March 5, voted $8,100,000 (£1,670,000) for the construction of dockage facilities, including $5,000,000 (£1,030,000) for the acquisition of the site and erection of six concrete wharves, 1,400 feet long and 150 wide, accommodating forty large steamships at one time. This port expenditure is for the purpose of instituting terminal facilities similar to the Bush terminals in Brooklyn, N. Y., and the city expenditures are to be duplicated by a New York corporation. This company intends to erect seventy buildings, including several six-story concrete industrial plants for the accommodation of manufacturers, together with modern storage warehouses with every facility for handling raw and finished products.

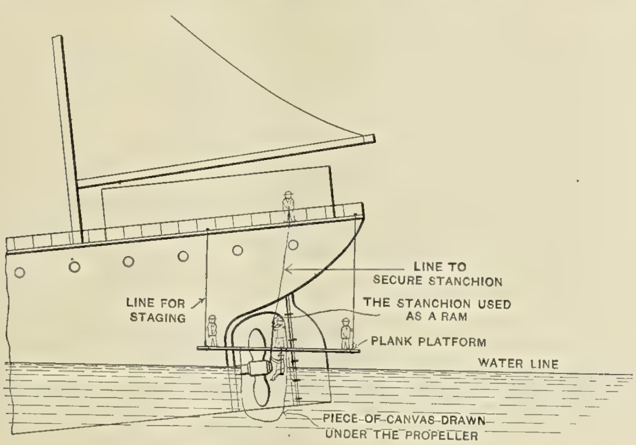
Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Tightening a Loose Propeller

Reading Mr. R. C. Hill's letter, "Fitting a Tail Shaft Ring," which appears in the current issue of the paper, brings to mind an incident in my own experience of a few years ago. It was on the *Orinoco,* a mail, passenger and freight steamer plying between New York and the West India Islands. I was fourth engineer at the time. It was sailing day, and we were just about to leave the pier, when the second engineer, in working the engines alternately ahead and astern, felt a slight jar at each reversal, which he interpreted to mean that the propeller was loose on the shaft. The chief was called, and he, too, worked the engines, but he professed to believe that the wheel was not loose, and so we started the voyage, some of us in doubt as to the outcome.

The first port of arrival was in the Island of Antigua, one of the British West Indies. We were six days getting there, and during that time all doubts about the wheel being loose had vanished; even the chief changed his opinion and became convinced that the propeller was loose in reality. We came to anchor, and a consultation was held as to what was best to do. The nearest dock was at the Island of St. Thomas, quite a distance from Antigua. Finally it was decided to trim the ship by the head, as described in Mr. Hill's letter, and make the attempt to secure the propeller again. The ship was

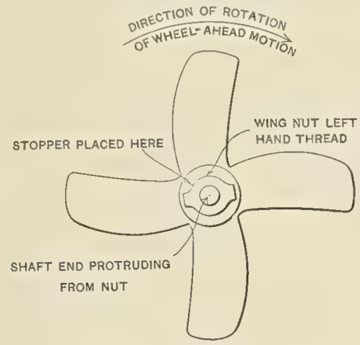


RIGGING FOR REACHING LOOSE PROPELLER

trimmed enough to just bring the propeller hub about level with the surface of the water. A staging was built, or rather slung, from the quarter-deck railings, from which we could get at the wheel. As there were quite a few sharks swimming around, a piece of canvas was run under the wheel and secured to the staging at the corners, and a man was stationed at each of the four corners of the staging to frighten off any of the finny tribe that might venture too near.

The nut was found to have slacked back against the stop, which stop had not been set up tightly against the nut, as it should have been. The amount of slack was not great, but enough to permit of the slight movement of the wheel on the shaft as at first noticed at the pier in New York.

The shaft was 13 inches diameter, and the largest sledge hammer we had on board was too small to make much impression on tightening the nut. However, some one suggested cutting out one of the 'tween deck's stanchions—which were about 3½ inches diameter, and possibly 10 feet in length—and using it on end as a battering ram to tighten up on the large nut. This was done. One of the engineers straddled the shaft where it projected out from the nut, and bracing his back against the rudder post guided the striking end of the improvised "ram," while others of the crew raised up and struck alternately blow after blow until the nut was up as tight



DETAILS OF PROPELLER

as the stanchion could make it under the attending circumstances. A rope had been attached to the top end of the stanchion and secured on deck in case of an accident, whereby we might lose our "ram" in the harbor.

The stop was set up against a wing of the nut this time, and that makeshift repair carried us back safely to New York, where the ship was docked and the job properly done.

Scranton, Pa. CHARLES J. MASON.

Fire Extinguishing Apparatus

I have read with much interest the description in your March issue of a new fire extinguishing apparatus. There are some points in connection with this plant that will, I think, be of interest to your readers.

The gas generated by plants of this type generally contains about 10 to 11 percent of sulphur dioxide and about 9 percent of residual oxygen. In the apparatus which you describe the gases, according to your article, are diluted by the air in the injection apparatus on the delivery side until the proportion of sulphur dioxide is reduced to about 6 percent. The air necessary to produce this amount of dilution contains 21 percent of oxygen, and therefore a quantity of air has been added sufficient to raise the percentage of oxygen in the gas that has to be used for fire extinction from about 9 percent to over 14 percent. Now the oxygen in the atmosphere must be reduced to at least 15 percent before the atmosphere is fire extinctive. If, therefore, the gas used in this system is fire extinctive at all it is only so to a very slight degree, it is obvious that before this gas would have any effect in extinguishing a fire the whole of the air would have to be displaced from the ship's hold before the fire could be arrested.

If the sulphur dioxide apparatus which you describe gets slightly out of order or the air valves are not properly adjusted, I think the plant would act as a fan to blow up the fire and not as a fire extinguisher at all. The difficulty in getting all gaseous extinguishers to work effectively lies in their not being able to supply the fire extinctive gases in the large quantities that are absolutely necessary for this purpose.

I am unable to understand from your article why the makers should expect the gas to corrode the fans and not the parts of the ship with which it comes in contact. An Engineer.

Editor's Note:—In reply to the above criticism the designer of the fire extinguishing apparatus referred to has the following to say:

I am always glad to answer criticism from one who evidently knows what he is talking about. In this case, however, your correspondent is reasoning from false premises, due to the fact that the article in question is not quite clear enough.

The apparatus described is designed for two purposes—fire extinguishing and fumigating. When used for fire extinguishing the full strength of the gas, say 15 percent or more, is used; the injection device on the delivery end is used only when it is desired to use the gas for fumigating. The testing instrument used in connection with the apparatus will show at once the required strength of the gas.

Furthermore, the manner of introducing the gas by this method precludes the possibility of mixing the gas with the air of the hold because of its greater specific gravity than air. The gas goes to the bottom, and as the space fills up the air is simply boosted upward and out. If we were simply talking from theory there might be room for discussion, but these are facts ascertained from practice.

A very good opportunity to observe the action of this gas in a ship's hold is when we fumigate the empty hold of a ship. I have often on such occasions left the hatch cover off for a time and looked down. The gas will form in the bottom of the hold as one may have seen a dense fog in a valley in the early morning with the atmosphere perfectly clear above

I must also take exception to another point in your correspondent's criticism, namely, as to the percentage of gas necessary to stop combustion. I have seen a 5 percent gas knock down flame and stop active combustion and thus bring the fire under control; we, however, advocate the use of a 15 percent gas, and this we have maintained for twelve consecutive hours without appreciable variation with our apparatus.

The interesting question which is raised in regard to the action of the gas on the blower in other apparatus I would answer in this way: The air used in the furnace contains, of course, the ordinary percentage of moisture, which by the heat of the furnace becomes steam; in the cooling of the gas before it leaves the apparatus this steam is condensed to water; the well-known affinity of water for SO_2 gas causes this water to absorb enough gas to become sulphurous acid, which passes through the blower, and what remains in the pump or blower is what does the damage. In this apparatus this acid can be drained off and never reaches the ship, and, of course, in this apparatus it does not pass through the blower, as only air passes through the blower. The reason, however, why sulphurous acid will destroy a blower and yet not damage the ship lies in the fact that corrosion of metals by acid is due to rapid oxidation, which only takes place, as in the case of a pump or blower, where the surfaces are continually wiped clean by the action of the machine. This condition does not prevail in the hold of a ship even should some acid reach there. At any rate, I have never found during many years' experience any damage done to a ship from this cause, but I have found blowers eaten to such an extent as to be inoperative, and this is usually discovered about the time you want to use it. Paul H. Grimm.

Unaccountable (?) Mysteries

No one who has been to sea in the engine room, or about engines ashore, but will have bucked up against the mysterious. Strange sounds that could not be accounted for in the main engine, or some erratic action of an auxiliary, or something that seems utterly inexplicable, is pretty sure to be met to set one wondering and thinking.

I used to almost think and worry my hair off in trying to account for noises, but I got so after a while that I did not fret myself so long as there was water in the gage glasses and no bearings hot. What makes me provoked is that time and time again I start in after a mystery and am ashamed of myself when I find it out, as it is always very simple after one knows the cause.

I was working over on a river, across the water, where at that time you could get a fight any Saturday night if you just called out "boil the bell" to any of the lads who were working at the yard below us. I wonder if any of your older readers who hail from the other side can remember the following story:

A ship came in for repairs, and some "prentice" lads were set to painting, which did not seem to please for some reason, so to do a good job they painted everything in sight, including the ship's bell. They gave it several good coats, at which the captain became proper mad when he saw the work and complained about it, and the men were set to work scraping the bell. But it was slow work, so someone proposed to unship the bell and boil it. This was done, but for some reason this treatment took the life out of it and made it sound as dead as a door nail, and another jolly row arose again. All hands got to guying the yard about the bell, and pretty soon it got on their nerves, as they say over here, and it was not safe to mention boiling a bell unless you had a chance to run for it, or wanted to put up your "dukes."

Well, I got off my story about mysteries. We had just fitted up a tramp, which was rather a high-toned affair for its class, and I was detailed to look after indicating the engine on her first run. The engine designer was aboard. I think it was the first "triple," so he was keen after the cards. After we got things going well I took cards from the high and intermediate, and they were very good, but when I came to the low I got a good card from the bottom end but never a line from the top. I got the designer below, and he went wild and just handed it out to the erecting boss, who handed it back, but no one could say what the trouble was, and the designer and the erecting boss did not speak the rest of the trip.

The indicator piping was a good-looking job, such as is usually put up, and I could see no reason for the mystery, and it troubled me no end. I thought that the indicator steam passage must not have been drilled through; but all hands swore that the work had been done properly, and to clinch it one of the drafting room force had a photograph made of the low-pressure cylinder, and it plainly showed the drilled hole, so I was, so to speak, still at sea.

One afternoon I was working about the erecting floor, where there was an engine about done, and the lagging gang came along to start the lagging. The gang boss had a big sheet of thick detail drawing paper, and he proceeded to lay it on the cylinders and cut out for the bosses and openings, so as to make a template to cut his sheet metal to. To do this he had the paper held to the cylinders, and he took a hammer and peaned around the bosses and holes, cutting the paper on the edges of the metal by the blows. I was watching him, when suddenly it came to me what was the cause of the mystery of the top end of the low-pressure cylinder, so I kept a sharp lookout, and sure enough when he peaned the paper at an opening a little circle like a gun wad was cut out, and it sometimes remained in the hole, and no doubt but that in the hurry to get the work done the wad was left in the top end indicator opening, and it, of course, acted like a blind gasket. I got hold of the "second" when the tramp next made port, and he told me that he got cards all right from the low, and he had noticed that when cleaning his indicators the one he used on the low was stuck up with some messy pulp, which was no doubt the remains of the mystery. Coupling.

Port Antonia, W. I.

Review of Important Marine Articles in the Engineering Press

The Raising of the Wreck of the United States Battleship Maine.—The official report of the preliminary operations of the raising of the *Maine* contains all details of the plans and carrying out of the same up until the completion of the cofferdam. Complete data of the most important part of the undertaking, with an account of the hurricane that hindered the work the latter half of October. 5,100 words.—*Engineering*, March 15.

Making Wax Models of Vessels.—An illustrated description of the process of making models in wax for towing in the model tank of the British Government in the National Physical Laboratory at Teddington. The process, briefly stated, is as follows: The wax being first heated in a tank capable of holding about 1½ tons and the impurities being removed, the rough mold for the model is cast. Upon being cooled the top side is planed perfectly smooth and then turned upside down to permit the cutting of the water lines in the body of the model. This is done by a rotary cutter guided by a pointer run over the lines of the ship and magnified in transmission to the size of model desired. With the water lines all cut, the rough places between are smoothed away until the model is fair. As a check upon this last operation a second series of cuts is made at the transverse stations. A verifying gear enables the form of the model to be traced back upon the drawing, thus proving the closeness of the similarity of the two. 1,400 words. Photographs and drawing.—*The Marine Review*, March.

The Case Against Increase in Caliber of Naval Guns.—An editorial review of a paper by Count Alessandro Pecori Giraldi, director of the Armstrong Works, Pozzuoli, which was read at the first Congress of Italian Naval Architects and Mechanical Engineers, held at Rome, Nov. 11 to 13. The Count is not adverse in his opinion to larger caliber guns considered *per se*, but when the necessary larger displacements must be arranged he endeavors to show that present large caliber guns are large enough. His principal argument is based upon a series of tests of armor and armor-piercing projectiles made with Krupp cemented steel plate. These tests showed that 12-inch projectiles of the 1910 model could pierce 16.1 inches of armor at a range of 4,400 yards and 12.6 inches at 7,700 yards; these figures applied to normal firing. Since these ranges were considered a maximum for effective firing in actual battle, and since the maximum armor belts of battleships now built and building were 12 inches, this size gun was considered sufficiently effective. Other considerations touched upon were weight involved and ease of serving of guns of the different sizes. 1,800 words.—*Engineering*, January 19.

Motors for Lifeboats.—The use of motor-driven lifeboats is becoming more general, there being at present nineteen in service on the English coast. This article describes the peculiar conditions of the service, the unusual requirements for motors so used, and a description of the boats now in use, together with tabulated data of the same. The latest views of Captain Holms, chief inspector of lifeboats of the Institution, and Mr. Small, his technical assistant, are given on the qualities required in the engines and their fitting up. Some of the most interesting and unusual of these are: Number of cylinders to be in all cases limited to four; no aluminum used in any part; reliability run for every engine of twelve hours without being touched; carburetor and magneto to be placed high, low-tension magneto preferred; valves to be on opposite sides with separate camshaft for each set; ability to run while boat is hauled up on slip with inclination of 1 to 4 longitudinally; ability to run while boat has a list of 25 degrees either way or a momentary list of 45 degrees, and, finally, that an arrangement be installed to automatically cut off ignition if the boat is heeled to an angle of 60 or 70 degrees, so that if the boat is capsized engines will not continue running and leave crew in the water. It is admitted that if anything happens to the motor when on active service very little more than adjusting a plug can be done by lifting a flap and protecting the opening with a dodger. If the trouble is more than this it is simply let alone, and masts and sails are raised or oars put out and the best progress possible made under the old conditions. Illustrated by photographs of the different motors used. 5,800 words.—*The Engineer*, March 1.

Internal-Combustion Engines for German Fishing Boats.—By F. Romberg, Charlottenburg. A review in English of this rather extensive German paper. The principal object is to show the development within the last five years of German engines for use in the fishing service. Previous to that time this field was supplied by foreign makers, either English, Swedish or Danish. Since then a very acceptable engine has been manufactured by the Gasmotorenfabrik Deutz, which is described in detail in this article. Illustrations of the engine, assembled and in detail, are shown, together with important designing and operating data. As to principal characteristics, it may be said to be a four-cycle, two-cylinder engine, with cylinders 200 millimeters diameter and stroke of 240 millimeters, running at 340 revolutions per minute. This gives a piston speed of about 540 feet per minute. Mean effective pressures have run as high as 61.7 pounds per square inch. Only in Diesel engines has this been higher. Since the pressure at the moment of explosion runs up to almost 750 pounds per square inch all important parts must be made heavy. Weight is not prohibitive in this service, but the main consideration besides simplicity is small space required. That this is realized is well shown in a drawing of a general arrangement accompanying. Other motors in use in this service are very briefly mentioned in the review. 1,900 words.—*Engineering*, March 1.

Semi-Diesel Engine on the Yacht Mairi.—A practical experiment by the Marquis of Graham upon this type of engine, which he has fitted to a private yacht and will run tests thereon, for the purpose of obtaining data upon points of design and performance with a view to finding the most suitable type of motor for oil consumption. This engine differs from the Diesel in having compression limited to 150 pounds per square inch and explosion pressure never greater than 300 with the lighter oils, and it is said never to exceed 200 pounds when using heavier oils, such as the Texas or Solar. A combustion chamber is needed for the starting of the engine, but after the first few minutes the heat of the cylinders is sufficient for ignition, and the usual Diesel cycle, with the exception of the excessive pressures, is gone through with. The engine works on the two-cycle principle, and has four working cylinders with a two-stage air compressor working off a fifth crank. It is reversible, and in recent runs has shown its ready maneuvering qualities. The cylinders are 9 inches diameter and 13 inches stroke, with designed speed of 350 revolutions per minute. The primary balance is complete, as shown by the fact that its running without vibration at 400 revolutions per minute. The motor yacht in which this engine is installed is 85 feet over all, with steel hull designed to highest class of Lloyd's Yacht Rules. On trial the *Mairi* made 10.3 knots, the engine turning the normal number of revolutions and developing 130 brake-horsepower. At this speed the

oil tanks have a capacity providing a cruising radius of 1,000 sea miles. 2,600 words. Illustrated with photographs and drawings.—*Engineering*, February 23.

The Towing Machine.—By Mr. Thomas W. Wilson. A paper read before the Institute of Marine Engineers Feb. 26. After explaining the need of such a device as the towing machine, due principally to the short life of hawsers without them, the author enters into a detailed description of various makes of towing machines as used in the American coasting, and to a less extent, in the foreign trade. While the manila hawser answers to a limited extent, the need of a spring between tug and tow, the great strain endured and exposure, render its life short, and after one trip its useful strength is much diminished. The towing machine is in itself a large winch, which receives the towline wound on the drum, the pull on the line being taken up by the pressure in the cylinder. The elasticity of the steam utilizes the load and enables the tug to make better time with the same load by automatically taking in or paying out the line as the pressure decreases or increases, respectively. The author describes in some detail the Shaw-Speigell machine, which was perhaps the earliest form used. A very complete analysis of the type manufactured by the Chase Machine Company follows, together with drawings and photographs. 3,900 words.

Modern Ore Handling Plant.—For the past two years the Pennsylvania Railway has been building a new ore-handling plant at Cleveland, Ohio. The growth of the Lake freight steamship made the previous docks undesirable, and so the new yards were begun on the outer harbor in the west breakwater. Approximately 1,000,000 cubic yards of filling were required to make the new land 1,850 feet long by 850 feet wide. The dock consists of a double row of 40-foot concrete piles supporting a concrete superstructure reinforced with 85-pound rails. The ore unloading machinery placed on top of this consists of four 17-ton Hulett unloaders and a 15-ton ore stocking and rehandling bridge. It is expected that when completed this will be the most complete ore handling plant on the Great Lakes. It is expected to be ready for operation at the opening of navigation this season. The article shows plans and photographs of the work and a complete description of the method of building and the method of working when completed. Making and driving of the reinforced concrete piling, operation of the Hulett unloaders and the ore conveying bridge receive detailed attention. The whole plant, including the handling of cars near the unloaders, is operated by electricity, a special power plant being provided. 4,500 words.—*The Marine Review*, March.

One Thousand-Horsepower Two-Cycle Diesel Engine.—The engine mentioned in the title and others manufactured by Messrs. Sulzer Bros., of Winterthur, are briefly described in this article. Although both two-cycle and four-cycle Diesel engines are made by this firm, the general pattern for both is the same. For powers up to 700 horsepower and for stationary plants the four-cycle type is recommended in preference to the two-cycle; the former does not require scavenging, but its flywheel is more than twice as heavy as that for a two-cycle engine of equal power. The use of two-cycle engines for powers greater than 700 horsepower requires a separate scavenging pump; but this forms a comparatively less important feature from the purely practical standpoint for the larger engine, because it does not supply compressed air at high pressure. There are given illustrations and descriptions of a 200-horsepower, four-cycle Diesel engine running at 375 revolutions per minute, a 1,000-horsepower, two-cycle Diesel running at 150 revolutions, and a two-cycle, six-cylinder marine Diesel engine. Following these is a statement of fuel consumption at reduced loads taken from exhaustive tests, showing that for reduction of power to one-fourth normal, fuel consumption per unit of power rises only 14 percent. 1,700 words.—*Engineering*, March 8.

The Marine Oil Engine.—A lengthy editorial on the present state of development of the marine oil engine, its problems which are most pressing for solution, and the tendencies of owners and builders toward favorable action for the new form of propulsion. Plans seem to be formulated too quickly for engines of large size of this type. For, while designs are said to have been made for battleship installations, the highest power yet developed in one cylinder is 2,000 horsepower, and that not without difficulty. There is now in course of construction by the Messrs. Krupp an engine to develop 3,500 horsepower; but this is done in twelve two-stroke cycle cylinders, which could scarcely be said to point to higher powers in the near future. The editors hold that the most useful thing to be done at the present time is the careful consideration of the mechanical difficulties encountered and the decision, from data obtained in experience to the present day, of such questions as the best type to use of the two or four-cycle, single or double-acting engine. Another question of importance to the marine engineer is that of auxiliary machinery. This has been met temporarily in several ways, but there is much to be learned as to which of these is most practicable. The question of obtaining oil fuel at reasonable prices is apparently not considered of prime importance by owners who are rapidly installing oil-burning systems under steam boilers. With the added experience of a year or two regular running free from breakdowns, these same men might be persuaded to install oil engines. For such reasons as these progress should be made slowly but surely at this time, when observation is critical. 3,400 words.—*Engineering*, March 8.

On the Wider Adoption and Standardization of Watertube Boilers.—By Mr. E. M. Speakman. A careful study of boiler installation requirements with the object of showing that watertube boilers could be advantageously considered for many ships not now using that type of steam generator. The author gives tabulated data showing types of boilers adopted by different navies, percentage of total boiler weights to displacement weights of vessels of different classes, structural data, including space required, weights and capacity of several types of watertube and cylindrical boilers. Drawings and photographs of the different types are shown, and in an appendix are carefully worked out problems in boiler design showing saving in weight and space of installations of watertube instead of cylindrical boilers. Throughout the paper reference is made to the gradual elimination of the differences in types and the increasing standardization of parts. This is most strikingly shown in the more concentrated use of a few well-known types whose excellence is becoming widely known. The article, which was a paper read before the Institution of Engineers and Shipbuilders in Scotland, gives much excellent data for general computing of boiler plants for marine work, and while of sufficient length to be given in three sections, all its paragraphs are well packed with useful information in the minimum of space. 12,000 words.—*The Engineer*, March 1, 8 and 15.

Wireless Telegraphy.—By Mr. John McLaren. Since wireless telegraphy has been so generally introduced in the merchant marine, a thorough understanding of its principles and operation is becoming more and more a necessity to the marine engineer. With the purpose of covering just this field, Mr. McLaren has prepared a very complete paper on the subject, and has furnished some interesting and instructive facts and figures on the Marconi system as commonly used in the British merchant marine. The apparatus described is illustrated by photographs and drawings. 8,350 words.—*Transactions Institute Marine Engineers*, March.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

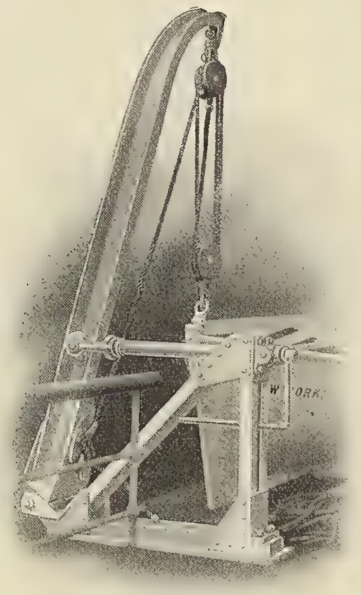
When it was predicted in these columns over six months ago that a revival in shipbuilding in the United States was about to occur, many of the business men in the marine field, who had suffered seriously from the recent depression in American shipbuilding, were reluctant to accept this prediction. To-day, however, those who are in close touch with the shipbuilding industry realize that this prediction has already been substantially verified, and that as soon as Congress has definitely settled the question of Panama Canal tolls in a just and equitable manner the activity in shipbuilding will assume far greater proportions than have been expected. Since the first of the year orders have been placed with United States shipbuilders for over 110 steamships of various classes. With one exception, these are all for coastwise trade. One steamship company has placed orders for 80,000 tons of shipping during the last six months, an order which has never before been equaled in American shipping history. Nearly all of the large shipyards on the Atlantic Coast have enough work on hand at the present time to keep them running at full capacity for more than two years. In some yards it is impossible to place an order for delivery inside of eighteen months. While the present condition is extremely satisfactory, there are still bigger prospects awaiting the decision of Congress in regard to the question of Panama Canal tolls, which will be an important factor in determining the immediate future of American shipbuilding.

In matters pertaining to inland navigation, and more particularly to ocean navigation, all maritime countries in the world are becoming more dependent upon one another, as far as methods of development are concerned. Water-borne commerce itself has experienced a tremendous growth during the last few decades, and there is every prospect of a still more marvelous growth in this direction in the immediate future. As oversea and inland water-borne commerce develops, however, there is imperative need for improvement in all matters related to navigation. For this reason the work of the International Congress of Navigation, a brief account of which is given in this issue, becomes of great importance; for here the ablest minds in the engineering profession from practically every maritime country in the world contribute their quota of practical experience in carrying out such work. The subjects considered naturally fall under certain heads, such as the improvement of inland waterways and ocean harbors, the practicable dimensions of such waterways and their relative effect upon the size of vessels, the types of construction used in such work, the mechanical equipment of ports and various other problems relating to the safety of navigation and the economy of water transportation. The first conclusion reached in the consideration of nearly all of these problems, however, is that no steadfast and uniform rule or method of development can be adopted, because the natural conditions differ so much in nearly every case that each problem must be considered by itself, so that its particular requirements can be met. This is particularly true in matters relating to inland navigation, although in ocean navigation more uniformity can be reached, as practically the same or similar means of transportation can be used in almost every port. But in whatever aspect, on account of the varied natural conditions in different parts of the world, any of these problems is presented, there is always something to be gained from the experiences which others have had in working along similar lines, and in the end certain features which have proved successful under somewhat different conditions can be adapted to the problem in hand. Therefore, the International Congress of Navigation, while it cannot establish fixed standards which can be followed in all places and under all conditions, can, by furnishing a vast amount of practical information on what has been done in matters pertaining to navigation, become a valuable source of information and serve an eminently useful purpose.

Improved Engineering Specialties for the Marine Field

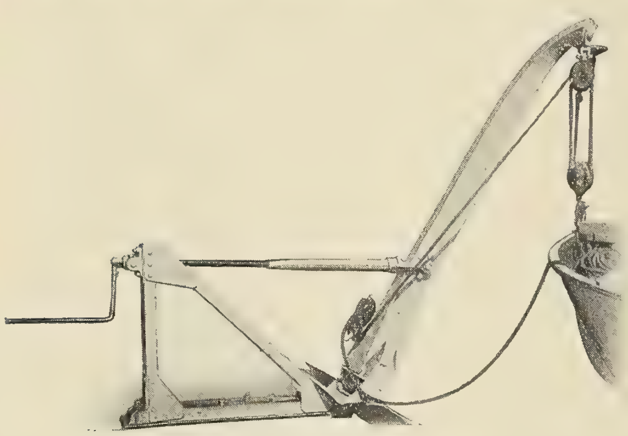
Sheath Screw Davits

A simple mechanically-operated davit for handling lifeboats on board ship has been invented and placed on the market by Mr. H. F. Norton, chief draftsman of the hull department of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. By simply turning a crank at each davit the boat is raised from its chocks on the deck and swung out from



SHEATH SCREW DAVIT IN STOWAGE POSITION

the side of the ship, when it can be lowered in the ordinary manner by the use of falls handled either from the deck of the ship or from the boat itself. The construction of the davit, as shown in the illustrations, is very simple. The davit arm is of structural steel; it swings about a fixed pivot which is supported at the gunwale of the ship. The movement of the davit is obtained from a tobin bronze screw operating in a sheath



SHEATH SCREW DAVIT SWUNG OUTBOARD

of steel pipe. The screw is supported by a structural steel frame. It is thus seen that the pivot for the davit is supported at a point where the structure of the ship is naturally strongest, and most of the fore-and-aft stresses are taken up at this point. The athwartship channel on the deck may be readily supported on top of a wood deck, or where desirable it may be incorporated with the deck frame. For instance, on the navy colliers building at the Maryland Steel Company these davits are being installed with the framing attached directly to skid beams.

One of the most striking advantages of the sheath-screw davit is that in stowage position the screw is completely in closed in the sheath. The sheath may be filled with grease by removing a small plate at the end, and although left almost indefinitely the screw will be thoroughly lubricated whenever the davit is used. It is by the same means protected from clogging with dirt or ice. It will be noticed that there are no guide sheaves of any kind for the falls. The davit being pivoted to one side of the boat chocks naturally lifts the boat clear of the chocks as it begins to swing out. This davit involves no complicated mechanism, so that anybody who has ever turned a crank or worked a pulley block can launch the boat successfully, whether he is a sailor or a "landlubber." These davits have already been fitted on the New York & Porto Rico Steamship Company's steamer *Isabella,* and are being fitted on the navy colliers and American-Hawaiian steamers now building at the Maryland Steel Company, Sparrows Point, Md. They are also under consideration for various other vessels building and for installation as auxiliary boat equipment for vessels now in commission.

The Lundin Decked Life Boat

A new type of lifeboat has recently been thoroughly tested by the United States Steamboat Inspection Service with very favorable results. The boat is the invention of Capt. A. P. Lundin, president of the Welin Marine Equipment Company, Long Island City, N. Y., who are the manufacturers of the boat.

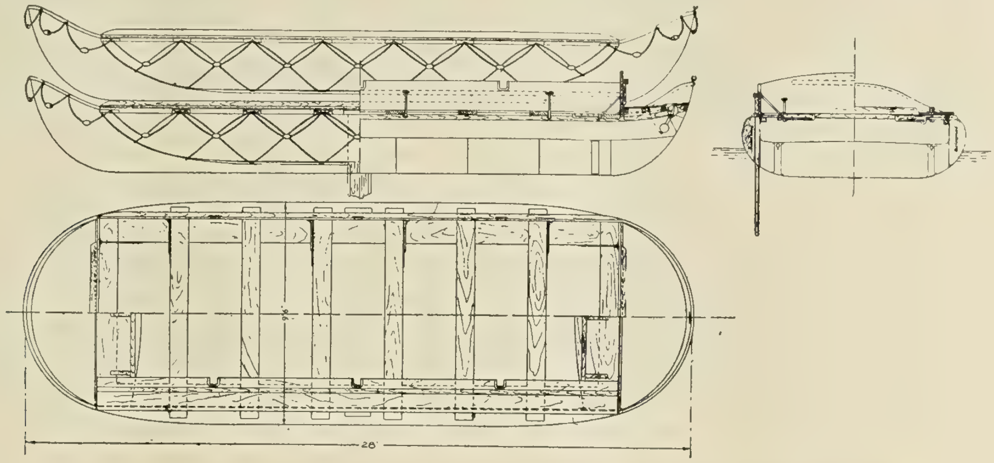
As shown by the illustrations the boat is built practically on the lines of a Norwegian skiff, with the exception that both ends of the boat are alike. The lines therefore insure by experience a seaworthy boat, which can be easily rowed, sailed and maneuvered when loaded to its greatest capacity. The hull has a flat bottom with rounded ends and flat sides. It is constructed of galvanized iron or other metal, the only woodwork used being the reinforcement over the gunwales,

LUNDIN LIFEBOAT LOADED TO FULL CAPACITY

the thwarts, the folding sides and ends above the fixed gunwale, besides light Balsa wood fenders on each side of the boat and small raised decks forward and aft.

The type of construction used in the boat is shown by the 'midship section. A watertight metal deck is fitted throughout the length of the boat, so that the lowest point of the deck is about 3 inches above the waterline when the boat is loaded to its full capacity. The space underneath the deck is subdivided by transverse watertight floors into a number of watertight compartments, one of which is fitted with a manhole plate for storing provisions, etc. Thus the boat is in reality a double bottom boat with numerous watertight com-

partments, so that it is practically unsinkable, and, due to its broad beam and buoyant fenders, is practically non-capsizable. The deck is provided with a self-bailing arrangement, by means of a suitable number of drain pipes fitted through the bottom of the boat, so that any water shipped in a rough sea



GENERAL ARRANGEMENT OF LUNDIN LIFEBOATS, ONE STOWED ABOVE THE OTHER

will run out while the entrance of water from outside pressure is prevented.

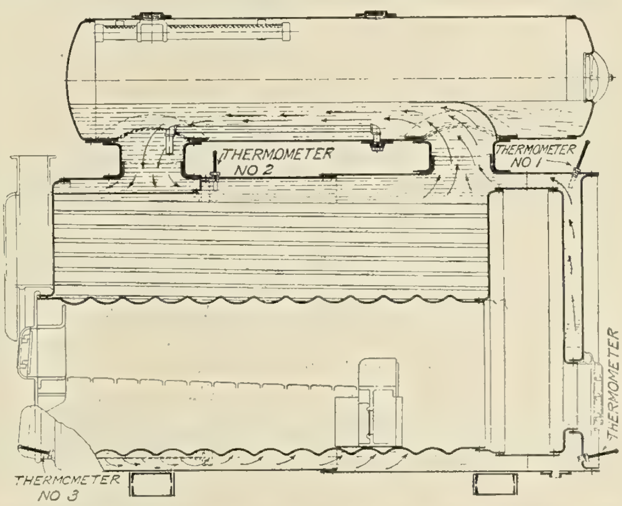
For the accommodation of passengers the space above the deck is fitted with thwarts and side benches on top of the fixed gunwale. The sides above the thwarts are made of wood, and are so arranged that they hinge down flat on top of the fixed gunwale, so that they can be raised in a second and automatically locked in place by means of sliding braces; protecting boards are then dropped into the ends. Oar locks are provided at each side, and a steering oar lock on each end. A wooden leeboard can be dropped in a pocket between the fender and the side of the hull on either side, so that the boat can be handled under sail. Water tanks are secured under the fore-and-aft thwart, one on each side amidships, and the spaces between the metal deck at each end of the boat provide a convenient place for storing various provisions and lifeboat equipment. The oars are secured with brackets on the outside of the folding sides, and masts can be secured to the top of the fenders, so that the inside of the boat is entirely unencumbered for occupancy by the passengers and crew.

The boat shown in the illustrations is 28 feet long over all, 8 feet beam of the hull proper, and 9 feet 6 inches beam over the fenders. The depth from the bottom to the fixed gunwale is 2 feet 8 inches and the depth to the top of the sides when raised 3 feet 11 inches. The capacity is sixty persons. For a given length of hull the manufacturers claim that these boats have about 20 percent more capacity than the regular type of lifeboat, and, inasmuch as when the hinged sides are folded down two can be conveniently stowed within the same space one above the other, in a given deck space of, say, 28 feet it would be possible to take care of 120 persons instead of only 50, which is the maximum carrying capacity of a 28-foot lifeboat of the regular type.

One of the most important features of the boat, however, is the stability and seaworthiness, which were thoroughly demonstrated at the test by the United States Steamboat Inspection Service. After loading the boat with sixty-two people the increased draft amounted to less than 5 inches more than when the boat was empty. Consequently, as can be seen from the photograph, there is a very substantial freeboard, exclusive of the folding sides and ends. By crowding the entire load to one side of the boat it was found impossible to bring the fixed gunwale below the waterline. The reason for this great buoyancy and stability is due principally to the large and extremely light Balsa wood fenders secured to the sides of the boat, and also to the fact that the watertight subdivisions in the hull, located to the best advantage, provide a greater amount of reserve buoyancy than is available in a regular lifeboat.

Circulating Test of a Robb-Brady Scotch Boiler

The Robb-Brady Scotch boiler is a modified form of the standard Scotch marine boiler, with changes from the standard form which, it is claimed, greatly increase the circulation. The heating surfaces are arranged as in the standard form, and there are the same internal furnace flues, but there are two smaller shells, one above the other, in place of the large one, and an annular circulating passage is formed at the front end by the use of a plate beneath the front neck. This plate guides the cooler feed water around the shell, discharging it



beneath the furnaces at the front. The water is heated while passing around the furnaces and among the tubes, and enters the steam drum by the rear neck.

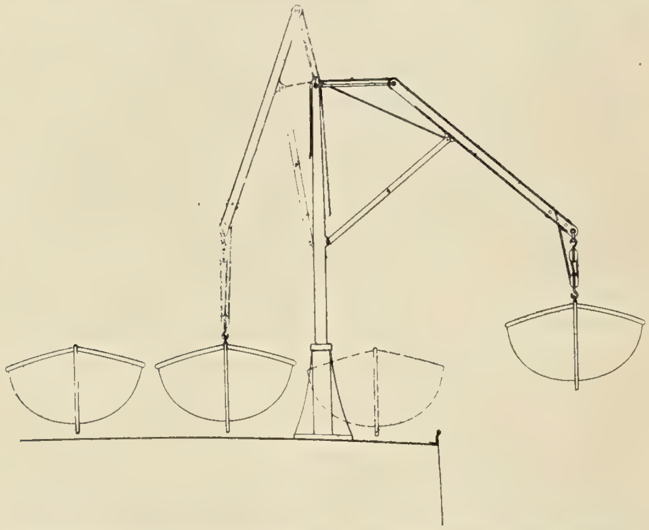
The claims for positive circulation, made by the builders, were thoroughly tested a short time ago at the Sewerage Pumping Station, Framingham, Mass. The Robb-Brady boiler at this plant was equipped with thermometer oil wells, so that the temperature could be noted at four points as follows: At the top of the shell near the front end, at the top of the shell at the rear just over the combustion chamber, at the front and rear close to the bottom.

With water in the boiler at about 80 degrees the fires were started and readings of all thermometers taken every five minutes. As was expected the temperature of the water at the top of the shell increased steadily until the boiling point was

reached. At the bottom the temperatures increased very slowly up to the time the upper thermometers indicated the boiling point. Then the lower thermometers showed a sudden rise; they jumped to within a few degrees of those at the top. From this time on all four kept within a few degrees until 100 pounds pressure was reached, at which time practically no difference could be noted at the four points, showing that the circulation was positive and rapid. The boiler is built under patents held by the Robb Engineering Company, Ltd., of South Framingham, Mass., and Amherst, N. S., Canada.

A New Type of Lifeboat Davit

A new type of davit, which involves some unusual features, has just been placed on the market by the McVeigh, Dougherty Derrick Supply & Equipment Company, Philadelphia, Pa. The davit is built to swing a boat loaded to its full capacity of passengers far enough from the ship's side to overcome the possibility of the boat's being smashed against the side of the vessel when launched in a rough sea. The davit has a reach as far inboard as it has outboard, so that after launching one boat it can reach back on the deck for the second and third, and launch them in succession as fast as they can be filled.



OUTLINE OF DAVIT REACHING INBOARD (DOTTED LINES) AND OUTBOARD (FULL LINES)

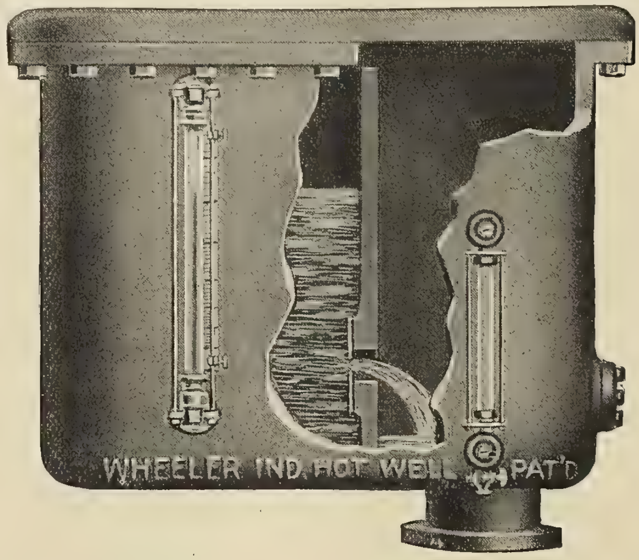
The reach of the davit also makes it possible to handle boats on the high side of a badly listed vessel.

As can be seen from the illustration the davit is simple in construction. It consists of a mast to which is attached a boom with a balanced cross-beam at its tip, which is fastened to the top of the mast by steel tie rods. The cross-beam turns on a pin bearing at about its middle point. To the other end of the beam is fastened a pulley, over which the cable for raising and lowering the boat is run. The load cable passes over a pulley near the upper end of the cross-beam, and thence to the mast and deck of the vessel. The beam is worked outward from the mast by means of a worm gear (not shown in the illustration), and is brought back again toward the mast by reversing the rotation of the screw. As this screw is short and is placed near where the mast and boom join, it makes it possible to move the davit out to its full reach by a few turns of the crank. If by accident this screw should break the davit will not fall with its load, as would be the case with an ordinary derrick, but the boom will drop only far enough to bring the load, the cross-beam, the connecting link and itself into a state of equilibrium.

One of the most important points about this arrangement of the davit is the fact that the boat remains at approximately the same level when the davit is being extended out to its extreme reach. Thus the load travels in a horizontal plane, and very little power is required for topping a load, as is necessary in an ordinary derrick. The reason for this is that the cross-beam tips down as the boom angle decreases, thus bringing about a saving in time and labor in manipulating the davit. All the work is done with boom angles of 45 degrees and less, so that the mechanism is very easy to handle. It is obvious that this type of davit takes up very little room on the vessel; that it can be handled rapidly, and, from its long reach, can launch several boats stowed side by side on the deck in a brief time regardless of the list of the ship.

A New Method of Measuring Steam Consumption

The steam consumed by a turbine or engine can be determined with absolute accuracy by weighing the "steam water" or condensate from a surface condenser. Very few plants have employed this method of measurement, due to the fact that ordinary weighing or measuring devices are costly and clumsy, and add not only extra expense but complicate piping, and withal are none too accurate. A simple, accurate and direct solution of the problem is presented in the indicating hot well, which is similar in size and appearance to the ordinary hot well, and is attached directly to the bottom of the



condenser, forming a part of the shell. This adds another valuable function to the equipment, which has for its purpose besides the maintaining of high vacuum that of providing pure distilled water for boiler feed, of heating this water to the highest feed temperature, and now the measurement of the amount of condensate and the rate of steam consumption of the engine or turbine.

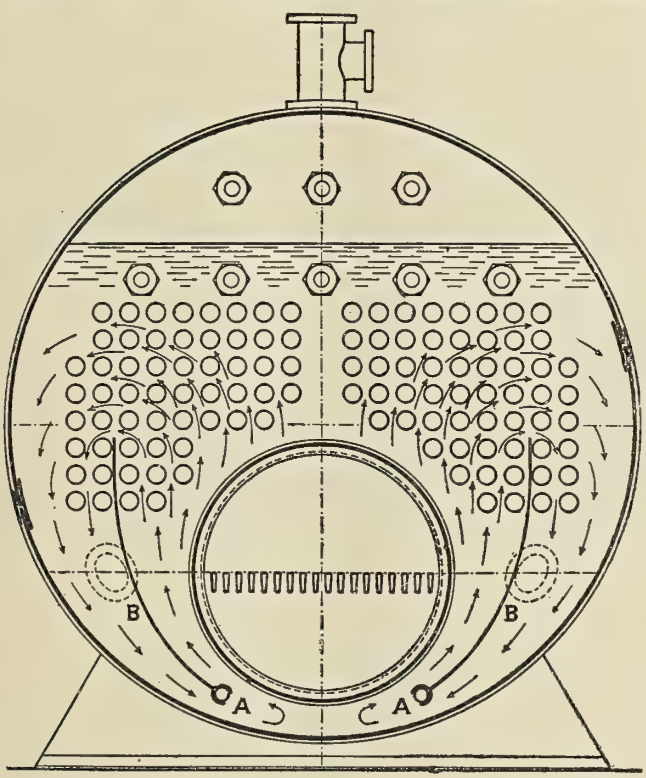
The indicating hot well is attached directly beneath the condenser. The opening in the bottom of the condenser is built so that the condensate drains into the left-hand chamber of the hot well, and communication from this chamber to the hot well pump suction is secured through an orifice in the dividing wall. The velocity of discharge through an orifice of given diameter varies directly as the square root of the head, and the quantity of water discharged is equal to the product of this velocity, the area of the orifice and the coefficient of contraction. With a properly designed orifice this coefficient remains almost exactly constant for widely different values of the head upon the orifice, and therefore the quantity of discharge is obtained with a high degree of accuracy by a carefully calibrated indicating gage glass, reading the head.

As may be seen from the illustration the orifice is formed in a brass plate inserted in the partition wall. It is polished

and finished to insure accuracy of flow. Especially manufactured fittings are used to attach the indicating gage to the shell of the hot well. Ball check valves are provided in each fitting, so that should the gage glass break the inflow of air will be prevented, and the gage glass can be replaced at leisure. A gage glass is also provided to show the height of the water in the hot well suction compartment, where the water must not be allowed to submerge the orifice. The scale attached to the indicating gage reads directly in pounds of steam per hour. Each orifice is made independently, carefully calibrated, and a special scale, etched upon steel, furnished for it. Over the whole range of readings the accuracy is claimed to be within 2 percent, and for readings from 75 percent to 125 percent load the accuracy is claimed to be within 1 percent. The indicating gage reads pounds of steam per hour; the station watt-meter gives load in kilowatts, and the rate of steam consumption in pounds per kilowatt-hour is obtained by simple division. This figure, entered regularly upon the engineer's log sheet and charted from day to day, is of the greatest importance in maintaining high plant economy. This device is manufactured by the Wheeler Condenser & Engineering Company, Carteret, N. J.

The Copeland Patent Automatic Circulating System

The automatic circulating system for Scotch boilers, patented by the F. T. Copeland Company, New York, consists of two rectangular plates of steel or other metal, of such length as to extend from head to head of the boiler, and of such width that when in position they will extend above and below the grate level or fire line. They are erected edgewise upon suitable means of support located below the grate line. The plates are curved to correspond approximately with the radius of the furnace. They are designed to reach from a point near

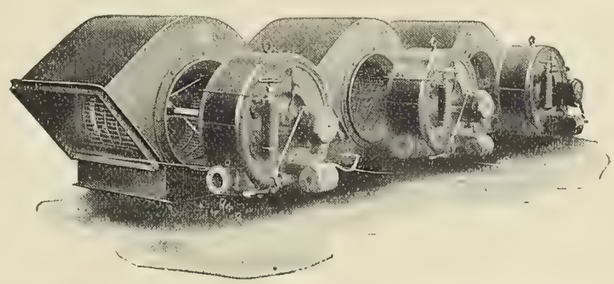


Tubes A A support plates B B and supply hot air to combustion chamber.

the center of the bottom of the boiler, to an indeterminate point above the bottom course of fire tubes. Tubes *AA* support plates *BB*, and incidentally supply hot air to the combustion chamber. Each plate becomes a partition which subdivides the space between the furnace and the shell, so that a pathway is provided for an uprising current on the inside, due to the heat from the furnace, and a down-flowing current on the outside, due to the greater density of the cooler water. Therefore it is claimed that the circulator establishes and maintains natural and complete circulation throughout the boiler; beginning immediately upon starting fires, and operating automatically and continuously until the fire is extinguished. The further advantages are claimed of increased horsepower capacity by causing the entire water contents of the boiler to travel over the heating surfaces; equalized temperature; improved combustion due to the admission of hot air to the combustion chamber, and improved boiler efficiency from the cleansing action of rapid circulation over the heating surfaces. This system can be applied to one, two, three or four furnace boilers.

A New Forced Draft Outfit

Unfailing constancy of operation has made the Terry turbine standard for running forced draft blowers. For use with a closed stoke hole system, the sets may either have a horizinal shaft with blower and turbine connected by flexible coupling, or they may be of the vertical type when required by torpedo boat destroyer or steam yacht practice. In the vertical sets the turbine is of standard single-stage type with the fan directly above it, and located on a line with the deck



at the foot of the ventilator. The whole unit is mounted on I-beams suspended from the deck to the bulkhead. The step-bearings as well as the turbine and blower bearings have forced lubrication.

The horizontal type is particularly compact and of light weight. There is no thrust in either the turbine or the fan. The wear on the rotating parts is small, as their only duty is to carry the weight of the light rotors. This type is free from such breakdowns as occur in high-speed fan engines from cracking cylinders or heads and water in the steam.

Particularly interesting are the three forced draft sets which have been furnished for the new Chinese training cruiser now under construction at the works of the New York Shipbuilding Company, Camden, N. J. These sets are located on the armor deck directly above the boiler room, and the air is discharged through openings in armor bar gratings in the deck. These sets occupy much less space than engine-driven units of the same capacity and only about half the head room.

Each turbine is designed for steam at 225 pounds initial pressure and back pressure of 10 pounds per square inch. The turbines are rated at about 60 horsepower, running at 1,220 revolutions per minute. Each is direct connected to a No. 5 double-inlet Sirocco fan of 30,000 cubic feet per minute against 3 inches static pressure. Each turbine is fitted with emergency governor, which comes into play and shuts down the machine in case the speed becomes excessive. They were furnished by the Terry Steam Turbine Company, Hartford, Conn.

Personal

H. McL. HARDING, consulting engineer for the design of terminal installations and freight-handling machinery, has removed his office to 17 Battery Place, New York.

THE COUNCIL of the Society of Naval Architects and Marine

Engineers elected on May 7 the following officers to fill existing vacancies in the organization of the society: Vice-presidents, Capt. A. P. Niblack, U. S. N., and George W. Dickie; members of Council, Commander L. N. Chandler, U. S. N., and Capt. C. A. McAllister, U. S. R. C. S.; associate member of Council, Henry S. Grove.

Obituary

ERNEST S. BOWEN, vice-president and general superintendent of the Fay & Bowen Engine Company, Geneva, N. Y., died April 27 from a severe attack of typhoid fever.

V. F. LASSOE, consulting engineer of the American-Hawaiian Steamship Company, New York, died May 22 of old age. He was born in Copenhagen, Denmark, in 1836, and began his business career in the United States with Mr. Ericsson, builder of the *Monitor*. For twelve years after the death of Mr. Ericsson, Mr. Lassoe was superintending engineer of the American-Hawaiian Steamship Company, and for the last year has been a consulting engineer for the same company. Mr. Lassoe was the inventor of the Lassoe system of fuel oil burning.

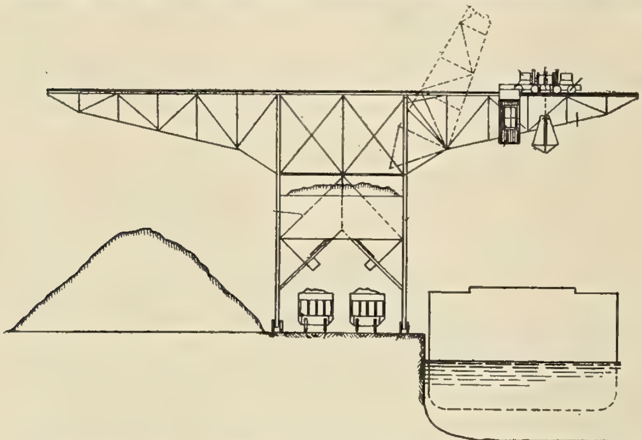
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,014,994. HANDLING, UNLOADING, STORING, AND RELOADING PLANT. HERMAN P. ANDRESEN, OF CHICAGO, ILLINOIS, ASSIGNOR TO DAVID J. EVANS, OF CHICAGO, ILLINOIS.

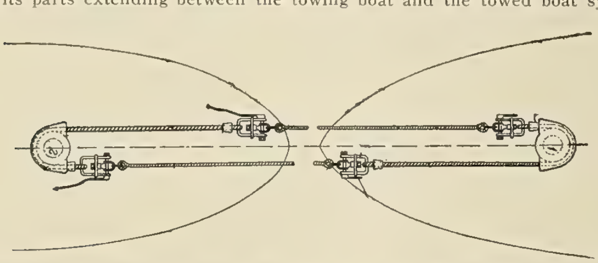
Claim 2.—The improvements herein described, comprising a storage dock having parallel stock pile spaces, in combination with tracks arranged at the dock front and between said spaces, a storage house at the landward side of said spaces, a traveling bridge constructed to travel



on said tracks and to overhang said house at the landward end, a hopper carried by the dock front end of the bridge, unloading means at said end of said bridge to deposit material in said hopper and a conveyer carried by said bridge for carrying material from said hopper to said house. Sixty-nine claims.

1,016,619. TOWING APPARATUS. LOUIS VICTOR WILLIAM FROGER, OF LORIENT, FRANCE.

Claim 1.—A towing apparatus for marine vessels comprising a cable in four parts, readily attachable and detachable connectors connecting said four parts into an endless cable, the cable being arranged with two of its parts extending between the towing boat and the towed boat sym-



metrically, and each of the other two parts of the cable being looped around fastening means on one of the boats and movable freely about said fastening means, thus tending to equilibrate the strains. Fifteen claims.

1,015,755. INVERTIBLE SCOW. WILLIAM E. COOK, OF ST. GEORGE, AND DANIEL HOWARD HAYWOOD, OF NEW YORK, N. Y.; FLORA G. HAYWOOD EXECUTRIX OF SAID DANIEL HOWARD HAYWOOD, DECEASED.

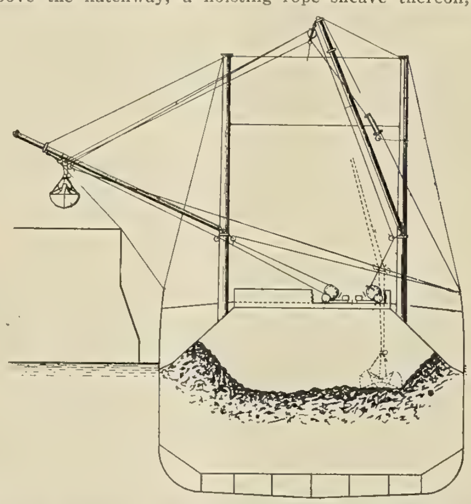
Claim 2.—An invertible scow having a water chamber therein, the upper portion of which is equally distributed upon opposite sides of a vertical longitudinal plane passing through the center of gravity of the vessel, the lower portion of which is unevenly disposed with respect to such longitudinal central plane, and means for admitting and discharging water to and from the said chamber. Five claims.

1,016,781. SAFETY DEVICE FOR SHIPS. WILLIAM S. SCARLETT, OF FALL RIVER, MASS.

Claim 1.—A safety apparatus for loading passengers into boats comprising a pair of davits with a block and tackle at each davit for connection with the ends of the boat, a collapsible safety conveyer and means intermediate the davits and independent of the block and tackle thereof for lowering the safety conveyer into the boat as held by the block and tackle of the davits, substantially as described. Two claims.

1,015,249. MARINE TRANSFER. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

Claim 1.—In marine transfer, a combination, a boat containing a hatchway, a pair of masts, a boom extending from one of the masts to a point above the hatchway, a hoisting rope sheave thereon, a second

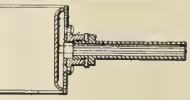


boom extending outboard from the other mast, an outhaul swinger rope sheave thereon, the swinger frame, the hoisting rope extending therethrough, the outhaul and inhaul swinger ropes and means for actuating the same. Thirteen claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

3,023. METHOD OF AND APPARATUS FOR OBSERVING MARINE CONDITIONS. H. T. BARNES, MONTREAL, CANADA.

Relates to apparatus for observing particularly the precise measurement of water temperature for ascertaining the presence of icebergs, shoals, etc. It has been suggested that icebergs might be detected by their cooling effect on the water, probably produced by water running from the berg, and spreading on the surface. Little use has been made



of this idea owing to the variable results obtained, since the thermometers in use could not read closer than one-tenth of a degree. With the new method and apparatus, temperatures can be accurately read to one-thousandth of a degree and continually recorded. The thermometer includes concentric tubes of heavy copper, with a space within which is the resistance coil having a resistance of one hundred ohms. The Wheatstone bridge method of measuring the resistance is used in conjunction with a Callendar recorder and Weston portable galvanometer.

18,854. SCREW AND LIKE PROPELLERS. A. J. MAHOUDTAU DE VILLETHIOU, PARIS.

In order to do away with the usual inoperative propeller boss which tends to impede progress, by this invention the propeller blades are supported at a distance from the shaft on a spiral mount which permits a free flow of water and is stated to give a much higher efficiency than the ordinary propeller.

19,123. BREATHING APPARATUS FOR USE UNDER WATER OR IN IRRESPIRABLE ATMOSPHERE. R. H. DAVIS AND SIEBE GORMAN & CO., LTD., LONDON.

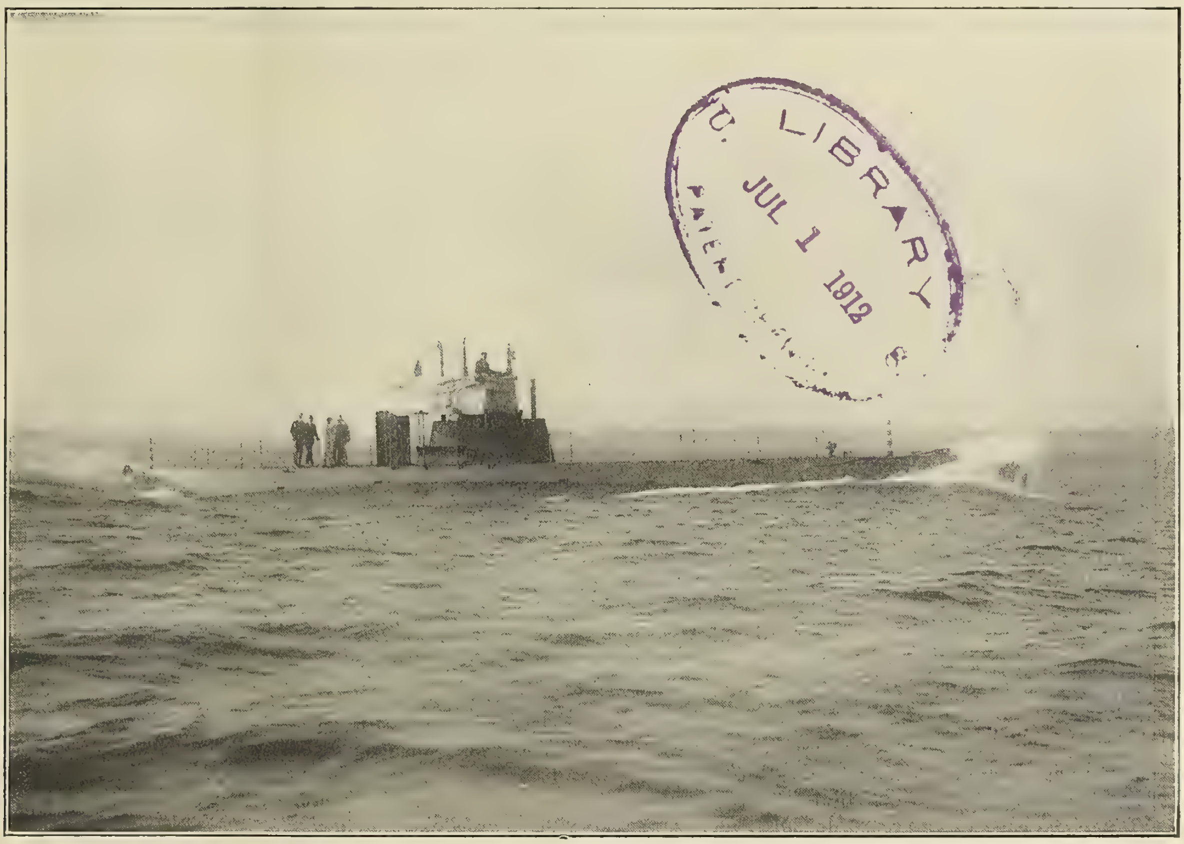
The apparatus comprises a watertight chamber to surround the body and provided with a pocket to hold a chamber containing a substance producing oxygen gas and at the same time absorbing the carbonic acid gas of the breath exhaled by the wearer. The chamber has a pipe leading to the watertight chamber, and also a piece for fitting to the mouth. The watertight chamber is provided with a tube having a valve at its lower end. The wearer breathes in and out of the regenerating chambr so that the nitrogen originally in the chamber is retained, the oxygen used up being replaced by that given off in the chamber. Where the apparatus is employed under water, say in a damaged submarine, where water is entering, the water compresses the air within the submarine until the pressures balance. To prevent collapse of the hollow chamber the valve controlled tube is raised above the water level and the valve opened so that the air pressure within the chamber also becomes equal to that within the submarine. The valve is then closed. When the wearer leaves the submarine the valve is opened under water. The air in the chamber can then escape gradually as the wearer rises to the surface and the pressure decreases, so that the danger of the chamber bursting is obviated.

International Marine Engineering

JULY, 1912

Modern Submarine Boats for the United States Navy

The United States submarines *E*-1 and *E*-2 were at first called Nos. 24 and 25, signifying that they were the twenty-fourth and twenty-fifth submarines which had been ordered by the United States Government. Later they were given the picturesque names of *Skipjack* and *Sturgeon*, in conformity with the practice of the department then in vogue. Very recently the fish names have been withdrawn from all submarines, and in place of the *Adder, Grampus, Moccasin* and *Pike* we have *A*-1, *A*-2, *A*-3 and so on, until we come to the *Skipjack* and *Sturgeon*, which are now known as *E*-1 and *E*-2.



UNITED STATES SUBMARINE STURGEON AT A SPEED OF 13½ KNOTS

They are the only two of their class, and may be termed an intermediate type between their predecessors and later boats. The contract for these vessels was awarded to the Electric Boat Company, New London, Conn., on June 3, 1909. Their construction was completed in the spring of 1911, and during the latter part of that year their official trials were completed successfully. The dimensions of these vessels are:

Length	135 feet 3 inches.
Breadth	14 feet 11⅝ inches.
Draft in cruising condition	12 feet.
Surface displacement	284 tons.
Submerged displacement, including superstructure	367 tons.

The metacentric height when the boats are submerged is 13 inches.

The hulls may be described as spindle shaped, or bodies of revolution; that is, their cross sections are for the most part circular in shape, which is the form best calculated to withstand the pressure incident to great depth of submergence. That their hulls are exceedingly strong is best shown by the fact that these vessels were actually submerged to a depth of 200 feet. At this depth the pressure is about 100 pounds per square inch, and being applied from the exterior is a much more severe test than when applied from the interior. Any defect or weakness in the design of the hull would, under such conditions, immediately cause it to collapse, resulting in the loss of the boat. On the other hand, a badly-designed boat might possibly withstand an internal pressure of the same amount, for the reason that the stresses due to such internal pressure would merely tend to make the boat assume a form having circular sections, and thus distribute the stresses on the various members. The difference between a test made with external pressure and one made with internal pressure can be best understood by a particular case. If we had a strip of steel of the same thickness as the hull it would be possible to support a great weight thereby if this weight were hung from the

strip of steel, keeping its fibers in a state of tension. If, however, the same weight were placed upon one end of the strip of steel and the other end was placed upon the ground, the fibers would be in compression, and unless the strip of steel was kept perfectly straight it would bend and collapse. Exactly the same conditions apply to the hulls of submarine boats.

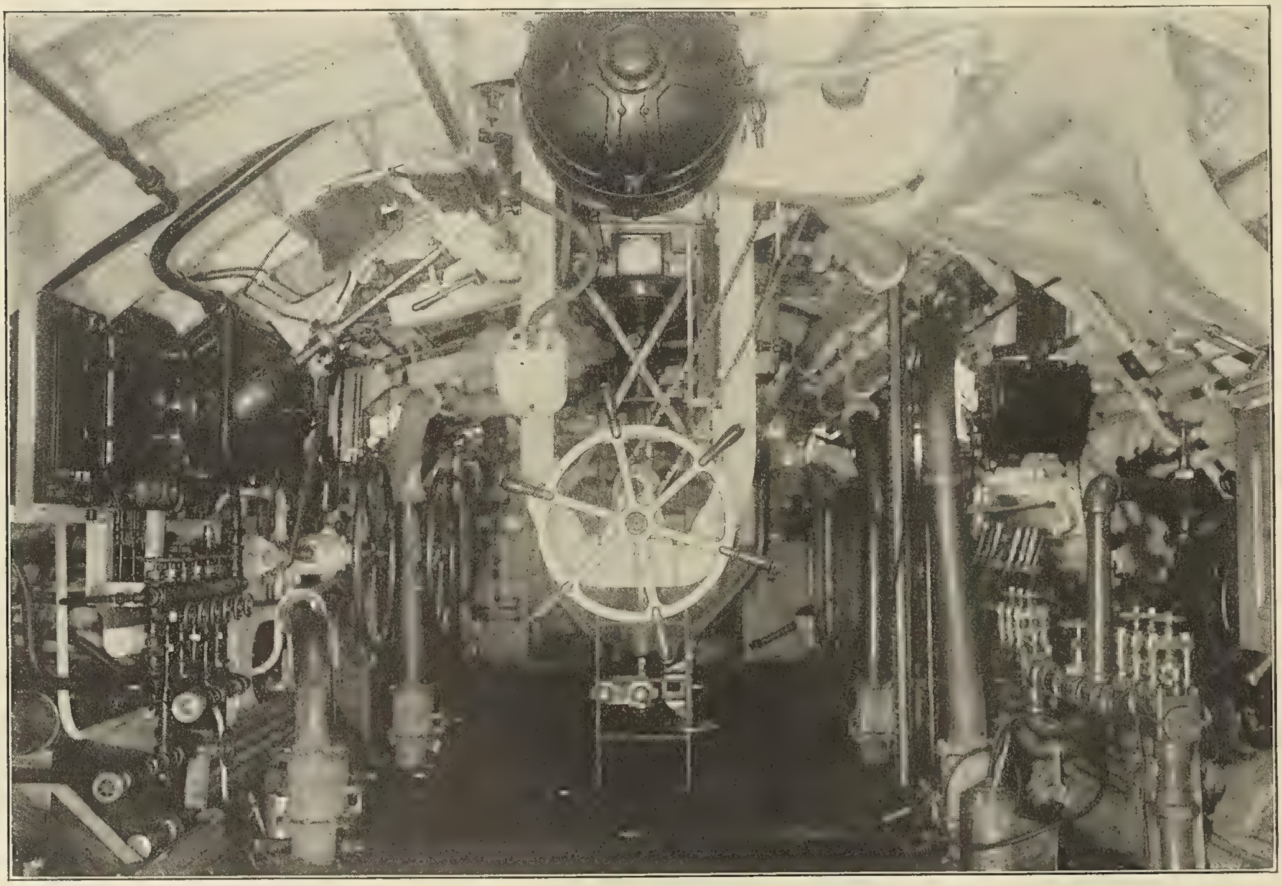
It may be interesting to our readers to know that all the submarines thus far acquired by the United States Government have been constructed to withstand safely a depth of submergence of 200 feet. So far as is known no other country has ever tested its submarines to so great a depth.

Two forms of motive power are supplied to these vessels, as is done to practically all other submarines in the world. For cruising on the surface and for traveling great distances the boats are propelled by oil engines. Two engines are fitted in each boat and they drive twin screws. Abaft the engines there is located on each shaft a large electric motor. These motors are used to propel the boat under water and receive their source of current from large storage batteries carried in tanks located above the inner bottom amidships. These batteries supply sufficient current to allow the boat to travel under water at high speed for one hour. By running more slowly it is possible for the boats to propel themselves completely submerged for twenty-four hours. In other words, the boats running at about 6 knots speed can travel fully 100 miles while remaining entirely beneath the surface of the water.

In addition to the main engines and motors a number of auxiliaries are provided, including air compressors, bilge pumps, clutches, ventilating fans and motors, periscopes, steering gear, air manifolds, water manifolds, together with numerous small motors and appliances for special purposes.

The sole armament of the submarine consists of its torpedoes. The bow of the boat is equipped with four torpedo tubes. The outboard ends of these tubes are closed by a bow cap, which is hemispherical in appearance and contains two apertures. When this bow cap is swiveled on an axial shaft the two apertures therein are brought in line with the torpedo tubes. As thus arranged two torpedoes may be fired simultaneously, or one immediately after the other. Then by means of a crank the bow cap is turned through 90 degrees and the other pair of tubes may be fired a few seconds later. In view of the great importance of the torpedo tubes and torpedoes, every effort is made to secure the perfect working of these parts.

Having thus described the principal features of one of these boats it may be of interest now to see how they are operated. Probably the best way to illustrate the functions of all the various parts is to describe what would be done in case a submarine were to start out and go through the various performances of which it is capable.



CENTRAL COMPARTMENT, LOOKING FORWARD

Assume first that the boat is tied up alongside of a navy yard dock with the crew on board, and that telegraphic orders are received to proceed immediately to some scene of hostility. The first action of the commanding officer, assuming the boat to be ready to proceed to sea, would be to send a couple of men out on the superstructure deck and take in the lines which were cast off from shore. These lines would be coiled down under a hatch in the superstructure deck. The boat would be stripped of everything except perhaps a life line running around the superstructure deck. The oil engines would be started and the boat would proceed down the harbor and out to sea. While thus proceeding she would do much the same as any other surface vessel. All of her superstructure deck and a large portion of her hull would be exposed above the sur-

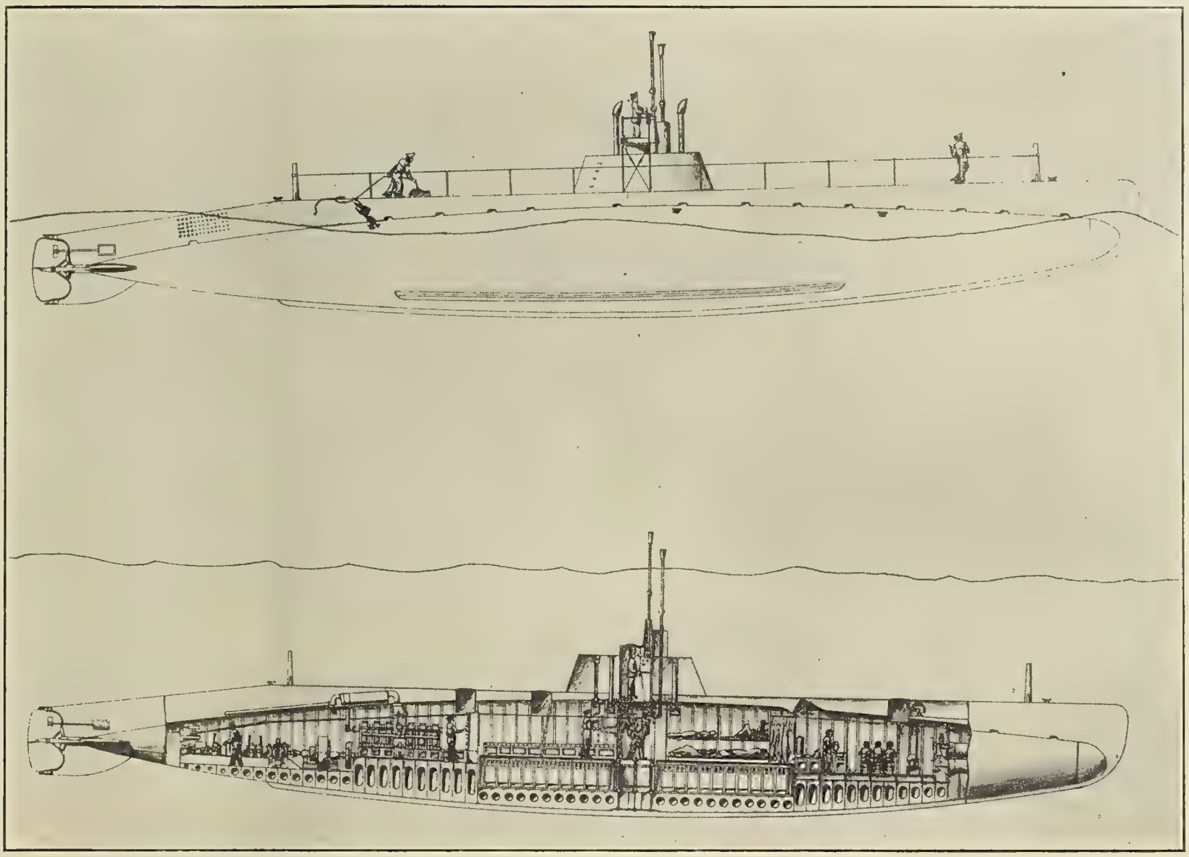
face of the water. The commanding officer would probably take his position on top of the conning tower on a light wooden grating forming the bridge, and steer by means of an electric push-button arrangement until the vessel is out at sea, when he would set the course by compass and turn the steering over to one of the quartermasters. The watches would be changed every four hours the same as on any other vessel, and there would be no very strenuous work for any one on board except the man in the conning tower and the two engineers on watch.

Upon arrival in the vicinity of the scene of hostilities, or upon sighting a vessel suspected to be one of the enemy, the commanding officer would give the order, "Prepare to dive!" At this order the life line, if rigged, would be taken down from the superstructure deck and passed below. All hatches would be tightly closed and secured. The main engines would be stopped and the ventilators lowered and closed. All of this would take less than a minute.

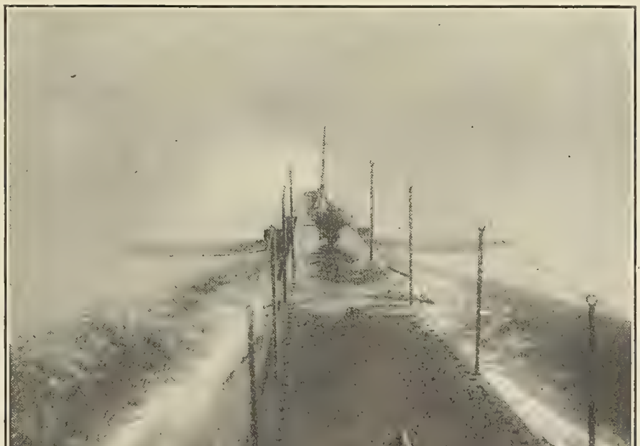
After assuring himself that all openings to the outside atmosphere had been closed, the next order given by the commander would be to fill the main ballast tanks. At this order a man stationed at a group of levers near the middle of the boat would pull over several of the larger ones, the gurgle of water could be heard as it rushed through large openings in the bottom of the boat past the Kingston valves until it filled the main ballast tanks, holding about 30 tons of water. As these tanks are filled the boat would rapidly sink until her superstructure deck is awash and only her conning tower would be exposed to view. She would still, however, have considerable surface buoyancy.

The next operation is to destroy this buoyancy and at the same time preserve the trim of the boat. The commanding officer would probably take his station in the conning tower, looking out of the deadlights, forward and aft, to see the two ends of his boat, when he would direct water to be placed in the forward or after trimming tank as required until the trim is level, or to his satisfaction.

The third operation is to fill the auxiliary ballast tank. This is a tank containing several thousand pounds of water, and is located directly under the center of the boat. The admission of water to this tank will, therefore, not affect the trim but will serve to still further sink the boat. Water is admitted until only the top of the conning tower is out of the water.



TYPICAL GENERAL ARRANGEMENT PLAN OF A MODERN SUBMARINE

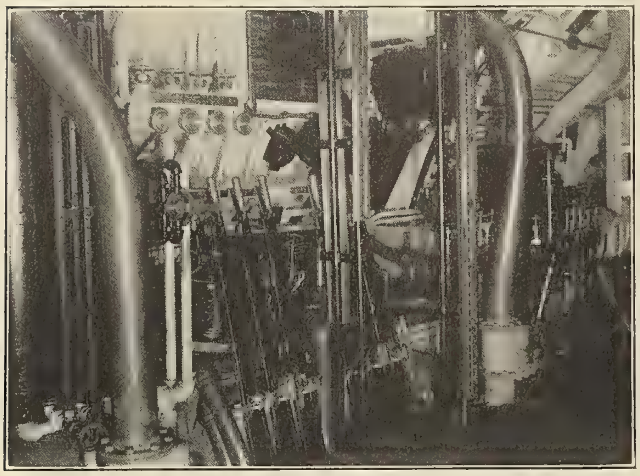


BOW RUDDERS EXTENDED

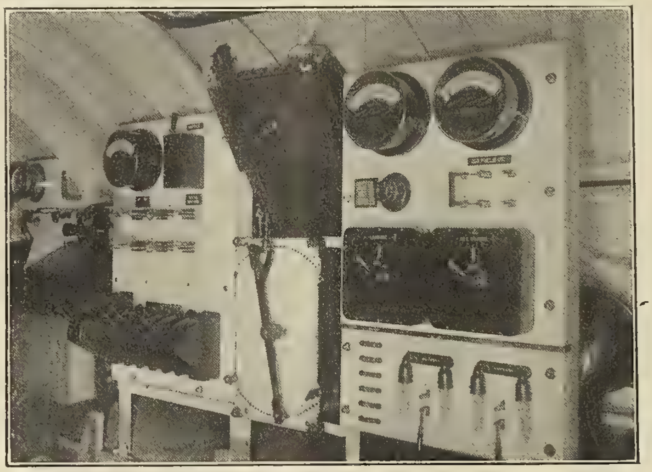
In other words, the boat at this time will have only 300 or 400 pounds of buoyancy, so that the admission of that amount of water would sink her below the surface, and she would

continue to descend unless the propellers were started or water blown out.

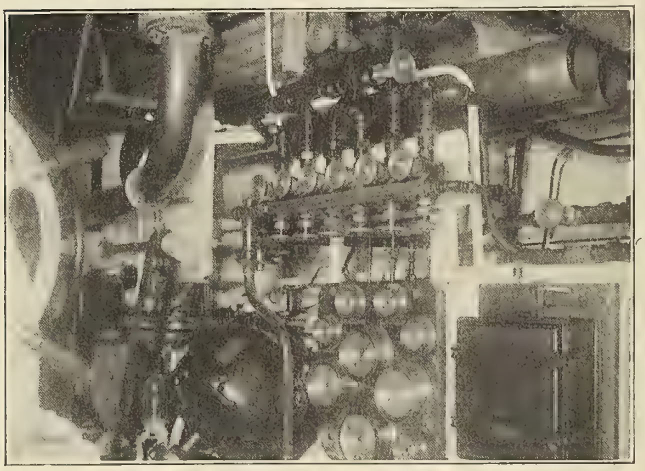
Having thus brought the boat to the desired trim, all of which would have taken only a few minutes, the commander rings a bell which displays a signal which the electricians understand as being an order to start the main motors. These motors are almost noiseless. The boat starts to forge ahead through the water. The diving rudder man is at the wheel, having in front of him a large gage, which indicates the depth at which the boat is running, and also a curved glass tube, or clinometer, which shows him whether her nose is pointing slightly up or slightly down. In the absence of any further orders from the commanding officer he would "keep her up"; that is to say, he would keep the boat running near the surface with the top of the conning tower exposed.



KINGSTON VALVES



CONTROL PANEL FOR ONE MAIN MOTOR—AUXILIARY CONTROL PANEL



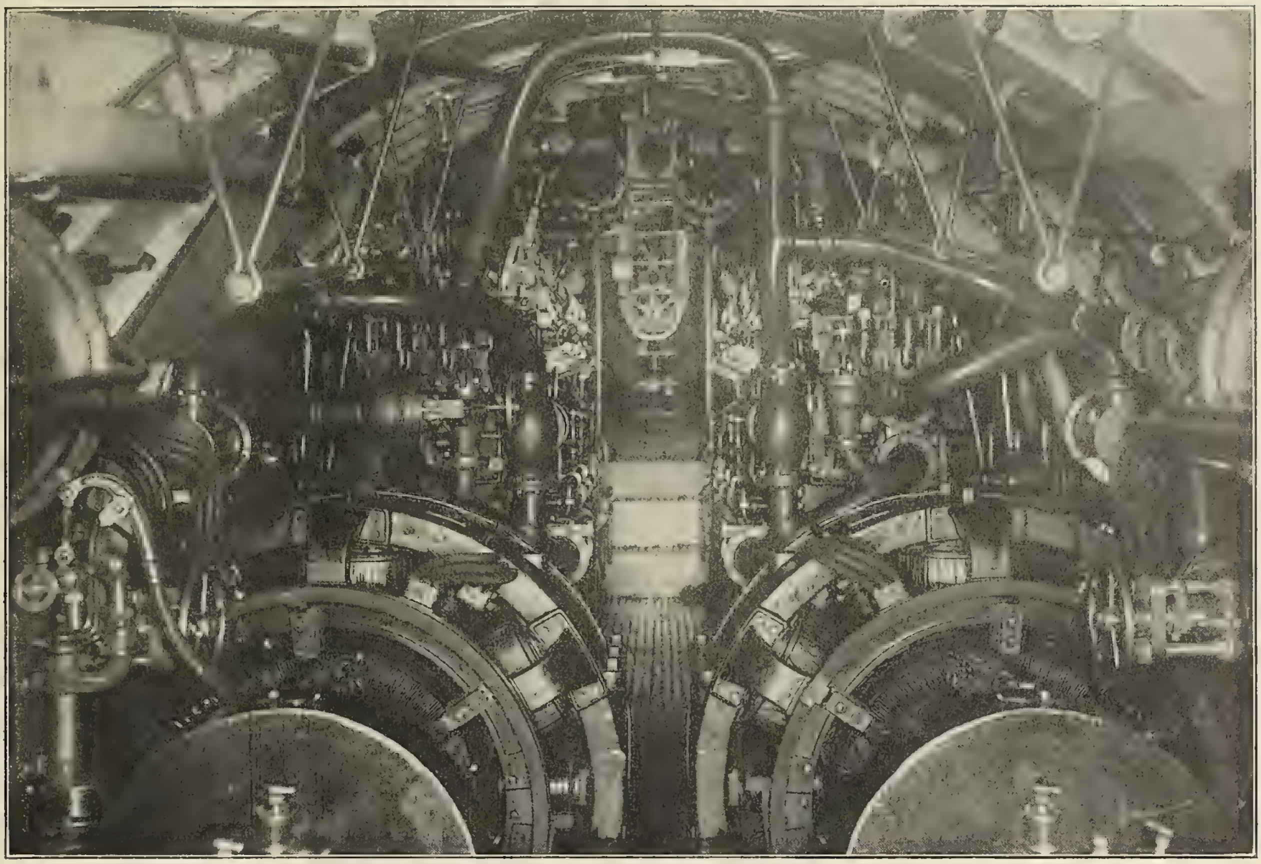
AIR CONTROL STATION

As soon as the commanding officer deems it time or advisable he gives the order "dive." At this order the man at the diving rudder turns his wheel; the diving rudder goes down, the boat takes a slight inclination forward, dives beneath the surface, and after having attained the desired depth is brought to the trim which will keep her running steadily at this depth. If the diving rudder man takes pride in his work he can keep the boat running for an hour continuously without changing the depth more than 1 foot. Even without exceptional skill or care it is possible for almost any diving rudder man to keep the boat running steadily without changing the depth more than 2 feet. The entire operation is exceedingly quiet. The motors themselves make no noise, so that one standing a few feet away from them would scarcely be aware that they were in operation.

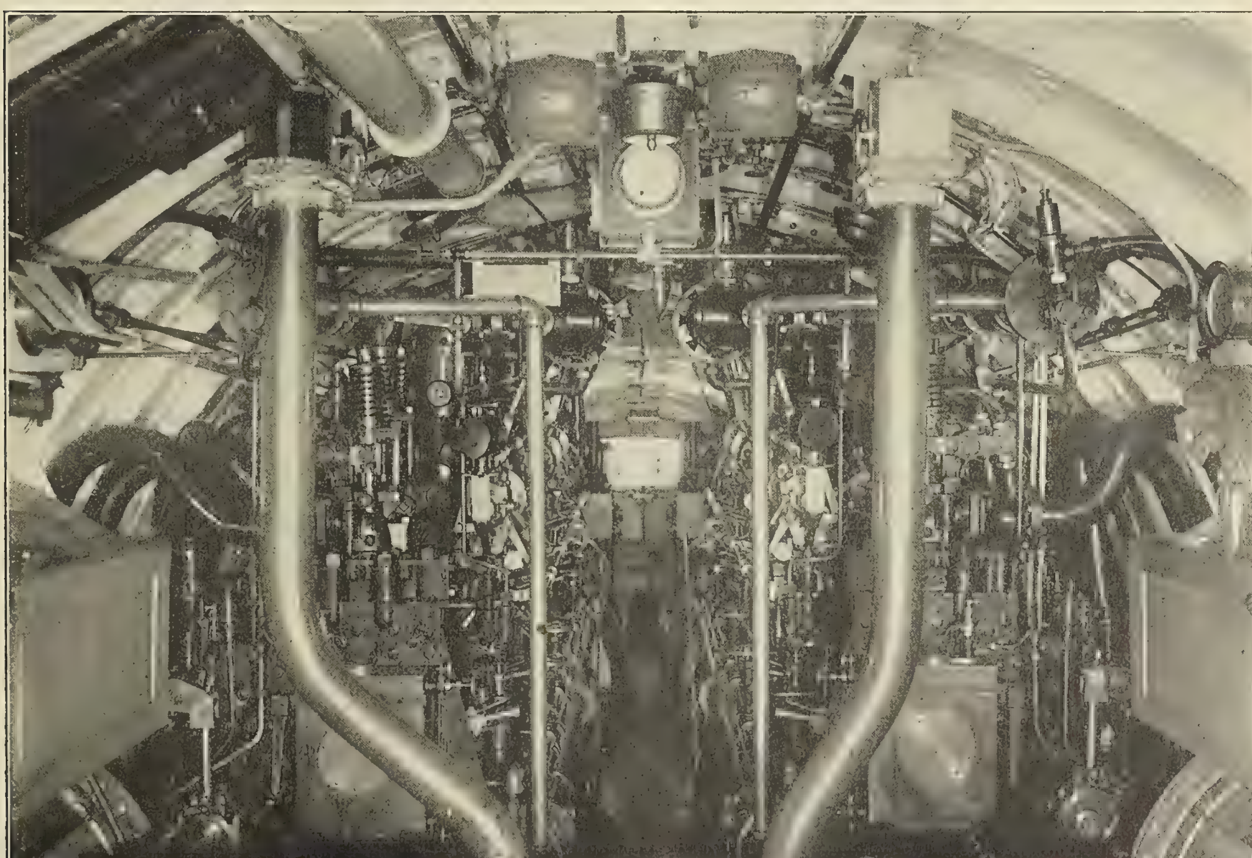
When running entirely submerged the course is steered by means of a compass; there being two available for this purpose, one inside the conning tower and another just abaft the conning tower. For the purposes of taking observations the boats are fitted with periscopes. In *E*-1 and *E*-2 these periscopes are of the telescopic type, one of them being located forward of the conning tower, the other abaft the conning tower, and both having their eye-piece in the body of the boat. They may be turned so as to look in any direction. Objects as seen through the periscope are slightly magnified, this magnification being used to overcome what may be termed an optical illusion, the usual observer having the impression that objects when seen at their natural size through a periscope appear smaller than when viewed with the naked eye. These periscopes may be rotated so as to obtain a view in all directions and have a field of vision embracing 35 degrees.

Assuming that while thus running submerged the commanding officer sights the enemy's battleship, he would probably run directly toward her, taking an occasional glimpse through his periscope, and then dipping the periscope completely under until he had arrived at a point where he considered a torpedo hit as certain. With the present type of torpedoes, and the present size of battleships, any range less than 2,000 yards, or 1 mile, is such as to be now considered a practical certainty. A few years ago, with the older types of torpedoes, probably 1,000 yards was the greatest range that could have been considered certain. If, however, the battleship was running too fast, or there appeared a possibility of getting closer than 2,000, or even 1,000, yards, the commander of the submarine would probably keep on until he came so close that he would be doubly sure of making a hit.

In the meantime, while directing the operation of the boat, he would be at the periscope, and have under his hand the firing lanyard, which at the proper moment would release the torpedo from the tube and send it speeding with its 200 pounds of high explosive toward the amidship portion of the enemy with the torpedo depth set at 20 feet. Probably a second, and even a third or fourth torpedo would follow the first at intervals of only a few seconds. With perfect torpedoes at this close range the almost certain results to follow this discharge would be three or four successive dull detonations, which could be felt by the hull of the submarine even at a distance of 1,000 yards from the battleship. Although these torpedoes would explode against the battleship's side so far below the surface of the water a huge amount of water would



ENGINE ROOM, LOOKING FORWARD



ENGINE ROOM, LOOKING AFT

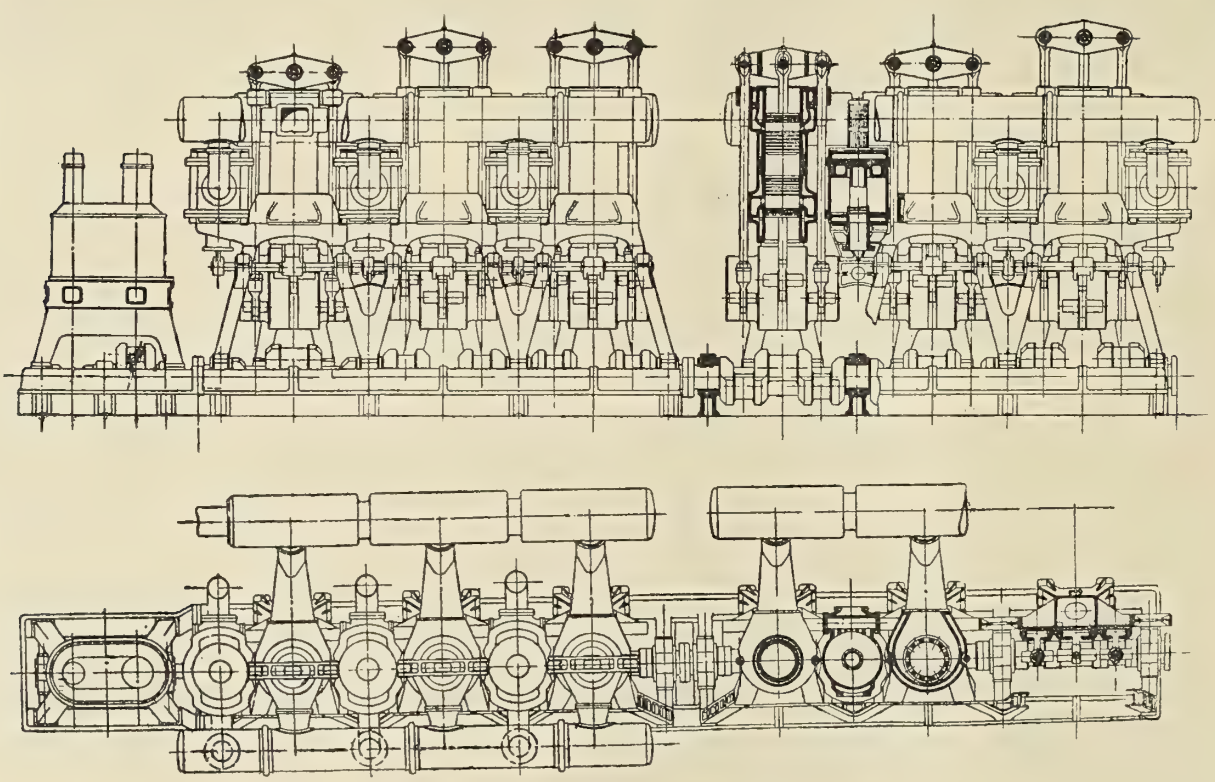
be lifted after the report of each explosion, and would be followed probably, as has happened in the past, by the careening over and gradual sinking of the battleship. In any event, a ship so attacked by four torpedoes may safely be considered out of action during the remaining period of hostilities.

Having thus finished her destructive mission *E*-1 or *E*-2 would then come to the surface. This is accomplished by giving the order "blow the main ballast," at which the man stationed at the air manifold would open a valve; compressed air would rush through this valve into a pipe leading to the top of the main ballast tank, and expanding therein would force out all the water which it contained through a hole in the bottom of the ship. The boat would then quickly rise.

If it is expected that she might have to submerge again then the water in the trimming tanks and auxiliary tank would not be disturbed. On the other hand, if she is expected to undertake a long sea voyage, without likelihood of having to submerge, these latter tanks would also be blown, the conning tower and ventilators would be opened, the oil engines started up, and she would start on her return voyage at full speed, running on the surface.

The Application of the Junkers Oil Engine to Marine Work

At a recent meeting of the German Schiffbautechnische Gesellschaft in Berlin, Prof. Junkers read a paper on "Studies and Experimental Work for the Design of Improved Large Oil Motors." In the discussion of this paper the view was expressed that the crude oil motor would prove to be the marine engine of the future. This view already seems quite justified, since at present there are a large number of vessels being built in which the propelling machinery consists of crude oil motors. As evidence of the progressive attitude of engineering circles in Germany, it should be noted that a number of German shipyards have acquired licenses for constructing this type of machinery.



ARRANGEMENT OF JUNKERS MARINE OIL ENGINE FOR NAVAL VESSELS

Recently the German Petroleum Company placed an order with Messrs. J. Frerichs & Company, Ltd., of Osterholz Scharmbeck & Einswarden (Oldenburg), for a twin-screw oil tank ship which is to be equipped with crude oil engines. The principal dimensions of the vessel are: Length between perpendiculars, 312 feet; beam, 44 feet; molded depth, 26.2 feet; total freight capacity, 4,cco tons. The vessel is of the full-deck type, designed to conform with the highest class of Bureau Veritas and the German Lloyds. It is to be built under the general supervision of both societies.

The propelling machinery will be installed aft. Forward of the machinery space is a tank extending for the full width of the ship, which is to contain the fuel oil. This tank extends up to the main deck. The main part of the hull is divided into ten oil-tight compartments for the cargo. Amidships is a chart house arranged on the bridge, providing accommodations for the captain and officers. Aft there is a poop deck, on which is a deck house containing the galley, officers' mess and the chief engineer's stateroom. Under the poop deck are accommodations for the engineers' assistants, other engineering personnel and cooks. Quarters for the seamen, boatswain, carpenter, etc., are also located aft. Gangways are provided, connecting the poop and bridge decks. Two steel masts give the vessel the rig of a schooner.

The pipe mains for filling and emptying the tanks, together with the corresponding hatches, are arranged in accordance

with the latest practice for oil-tank vessels. Two vertical pumps of 3,600 tons daily capacity are located in the after cofferdam, which is designed as a pump house.

The propelling machinery consists of two reversible heavy oil marine engines, having an aggregate horsepower of approximately 1,500, designed to give the vessel a speed of 10 knots. The engines are to be built according to the patents granted to Prof. Junkers, the principal features of the Junkers type of oil engine being simple design, presence of only one operating valve and reliability of operation.

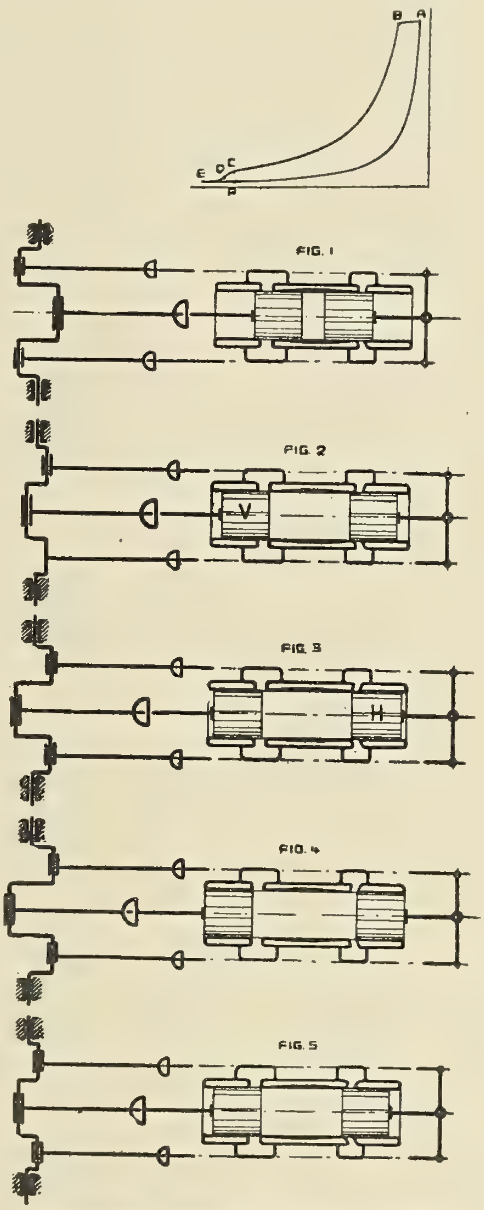
As the Junkers engine differs materially from the other types of internal-combustion engines for marine work, the following general description of the construction and method of operation of this engine is necessary to understand its special application for marine work: The early experimental work on this type of engine resulted in the development of stationary engines, which were principally horizontal engines. When the same principles were applied to marine work, the vertical type of engine was, of course, necessary. The general features of both the horizontal stationary engine and the vertical marine engine, however, are much the same, as can be seen from the following:

In the horizontal stationary engines there are two cylinders, placed one behind the other or in tandem form, each cylinder containing two pistons. For this arrangement there are three cranks placed at 180 degrees. The middle crank is connected to the two outer pistons and the two outside cranks, which are set 180 degrees in relation to the middle crank, are connected to the two inside pistons. This connection is made by transverse pieces and side rods, as will be seen from the drawings. The diagram on this page shows the general arrangement of this mechanism. The engine works on the two-cycle principle, and by means of the tandem arrangement of the cylinders the engine becomes a double-acting engine, in which every stroke is a working stroke. While the pair of pistons in one cylinder is executing an outward movement (working stroke) the pistons of the other cylinder execute an inward movement (compression stroke).

When the two pistons in one cylinder approach each other the injection of fuel commences. At the same time the two pistons in the other cylinder are separating, until at nearly the end of the stroke the expanded gases are driven out by the admission of scavenging air, which enters through a row of ports at one end of the cylinder, and, driving the spent gases away in front of itself, expels them at the other extreme end of the scavenging space. Complicated governing mechanism and scavenging valves are thus obviated, since the opening and closing of the ports is accomplished by the movement of the working pistons. Since the expansion of the gases takes place between two pistons, which move in opposite directions in the same cylinder, cylinder covers and stuffing boxes are dispensed with.

The action of the Junkers engine may be clearly understood from the diagram on this page, in which for the sake of simplicity only one cylinder is shown, whereas in practice there are two cylinders, one behind the other, or in tandem arrangement.

Fig. 1 shows the inmost position of the pistons. The combustion space between the pistons, immediately after a compression stroke is filled with highly compressed and, consequently, highly heated air, so that at that time and during part of the ensuing outward stroke the fuel, which is injected by means of compressed air in a finely divided condition, ignites and burns under an almost constant pressure during the first part of the outward stroke, or during the part shown from *A* to *B* on the indicator diagram shown herewith. During the remainder of the outward stroke the products of combustion expand, as shown in the indicator diagram from *B* to *C*. At *C* the pistons have reached the position shown in Fig. 2, where the front piston *V* is about to open the ports in the cylinder wall through which the burnt gases exhaust to the atmosphere. Up to the position of the piston shown in Fig. 3, or that part of the indicator diagram shown from *C* to *D*, the pressure in the cylinder has been reduced approximately to that of the atmosphere, and in this position the rear piston *H* opens the ports at that end of the cylinder, admitting fresh air to the cylinder at low-pressure, which scavenges the cylinder of the remaining burnt gases. This action continues until the outer dead center position of the pistons, Fig. 4, has been passed and the pistons have reached about the positions shown in

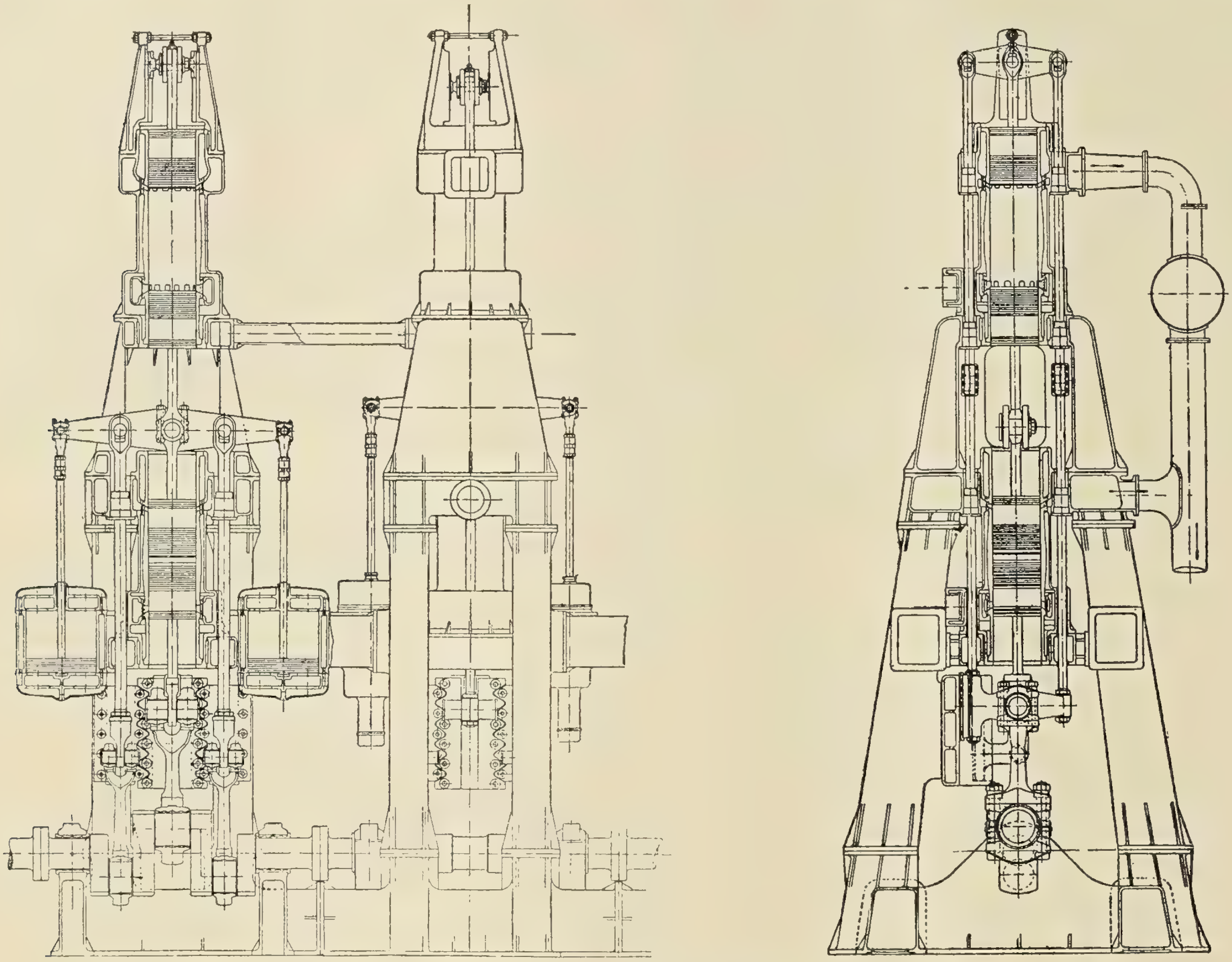


EXPLANATORY DIAGRAM OF JUNKERS ENGINE

Fig. 5, in which the pistons on the return to the inner dead center have closed their respective ports. This is shown on the indicator diagram by the part from *D* to *E* and to *F*. At the point *F* the cylinder is filled with fresh air, and from this point, as the pistons approach each other up to the inner dead center in Fig. 1, the contents of the cylinder are compressed. This part of the stroke is shown on the indicator diagram from *F* to *A*. The air which is thus compressed in the cylinder becomes heated to such an extent that the fuel which is injected at or shortly before the point *A* is reached ignites immediately, whereupon the working stroke is repeated.

The details of construction of the type of this engine which

is used for marine work are shown on pages 262 and 264. The scavenging pumps and compressors (in this case four-stage) necessary for the production of the scavenging and fuel spray air are arranged symmetrically with respect to the cylinder axis. They are actuated from the transverse bar attached to the middle pair of pistons. This arrangement makes the weights of the reciprocating parts of the inner and outer power transmitting devices equal, and, further, affords good control and accessibility as well as a good distribution of scavenging air, small mechanical losses and simple, substantial and inexpensive production and erection.



GENERAL DESIGN OF JUNKERS ENGINE FOR MERCHANT VESSELS

Each cylinder where the diameter is large has two fuel spray valves and one compressed air starting valve. The fuel injection is so designed as to give the fuel oil a close contact over a large surface with the combustion air in the dead center position and during part of the working stroke.

INDICATOR DIAGRAMS FROM 200-HORSEPOWER ENGINE

It is claimed that this type of engine offers a decided advantage for balancing the moving parts and the action of the forces as compared with usual engines of the Diesel type, inasmuch as the free forces are completely balanced in the centerline of the engine, neglecting the error due to the obliquity of the connecting rod. Moreover, the main bearings are relieved from their loads, due to the interlocking of the forces in the driving elements.

In the Junkers engine the cylinders are simple castings. They have no forces to transmit and are free to expand. The side rods which take up the acting forces are made of forged material. The cylinders have no covers, which, as is well known, constitute a constant source of trouble in oil engines. One side of the pistons is always in contact with the atmosphere, and the pistons are always in contact with well-cooled cylinder parts which are not touched by the products of combustion. In this way efficient lubrication of the pistons can be obtained.

By the division of stroke, which is accomplished in this engine by the use of two pistons moving in opposite directions, it is possible to obtain a relatively small piston speed at a high rate of revolution. On account of the long stroke in this engine the ratio of surface exposed to the volume of the combustion space is comparatively small, and so the quantity of heat transmitted to the cylinder walls during the combustion in the first part of the stroke is much smaller than in other types of Diesel engines. This advantageous ratio of surface to volume of combustion chamber also means that with a given compression space the compressed air is less cooled towards the end of the compression and thus a steeper rise of the compression curve is obtained, which insures the necessary ignition temperature even at low rates of revolution. The inventor

of this engine claims that this fact is of great importance in running with heavy fuel and especially for the decrease of revolutions in marine work.

The scavenging arrangements in this engine also improve the operation of the engine, since in this class complete scavenging is thoroughly and easily accomplished. It is also claimed that since the charge of air drawn in does not become heated until compressed, a larger indicator diagram with a higher mean effective pressure and greater specific output are obtained in this design than is possible in the usual type of Diesel engine, since a colder air charge is obtained.

The general design of the Junkers marine engine for mercantile marine work is shown on page 264. The tandem arrangement is used here, since there is usually little difficulty in obtaining the necessary height in the engine room. A solid sub-structure overcomes the action of couple forces.

In the adaptation of this type of engine for warships the horizontal tandem arrangement, such as is used for stationary engines, offers distinct advantages from a constructive, shipbuilding and military standpoint, but if the designer is forced to use the vertical type of engine the conditions attending the tandem arrangement must be forfeited and a single cylinder arrangement adopted, as shown on page 262.

For engines designed for warships, Prof. Junkers has applied a special method of increasing the output, which consists of throttling the exhaust gases in the exhaust mains simultaneously with supplying a greater weight of air at a proportionately higher initial pressure by means of larger scavenging pumps. In this way a larger amount of fuel can be burned. Two diagrams are shown superposed (page 264) which were taken from a 200-horsepower experimental engine, in which the smaller was taken at normal load and the larger at 50 percent overload. As a warship is seldom required to run at full power except for short periods of time, the application of a suitable margin of overload in combination with the Junkers engine is of considerable advantage. In the merchant marine, however, conditions are just the opposite, as the vessel usually has to run continuously under full power and maneuvering is required only on entering or leaving a harbor.

On the oil tank vessel which is under construction at Messrs. J. Frerichs' Company's shipyard, the exhaust gases from the engines are carried out through a funnel. An auxiliary boiler is installed for heating purposes and the operation of the auxiliary machinery.

Launch of a Steel Screw Steamer at Stockton-on-Tees

On March 18, Messrs. Ropner & Sons, Ltd., Stockton-on-Tees, launched from their shipbuilding yard a steel screw steamer of the following dimensions, viz.:

Length	392 feet 6 inches.
Breadth	56 feet.
Depth	26 feet 9 inches.

The vessel will be classed 100 A1 at Lloyd's, having main deck, poop, long bridge and forecastle. Accommodation for the captain, officers and engineers is in houses on the bridge deck, with the crew in the forecastle. The vessel has a double bottom for water ballast on the celullar principle, and fore and after peaks. The appliances for loading and discharging cargoes expeditiously are very complete, and include ten steam winches, double derricks to each hatch, steam being supplied by a large donkey boiler, working at 100 pounds pressure per square inch. The engines will be of the triple-expansion type by Messrs. Blair & Company, Ltd., Stockton-on-Tees, of about 2,450 indicated horsepower, having three steel boilers, 14 feet 9 inches by 11 feet, working at 180 pounds pressure of steam.

A Canadian Liner

Scott's Shipbuilding & Engineering Company, Ltd., Greenock, launched in March the steel twin-screw steamer *Letitia*, built to the order of the Donaldson Line (Donaldson Bros., Glasgow), for their service between the Clyde and Canada. The *Letitia* is handsomely modeled. Her pricinpal dimensions are: Length between perpendiculars, 470 feet; breadth (molded), 56 feet 8 inches; depth (molded), 39 feet 6 inches to the shelter deck, above which are fitted poop, bridge, forecastle and boat decks.

The vessel has been designed for the emigrant trade, and takes the highest class at Lloyd's. The accommodation for second class passengers is fitted on the bridge. Shelter and upper-deck staterooms are provided for over 300 passengers of this class. The dining saloon, music room, writing room and smoke room are handsomely paneled in polished hardwood and very comfortably furnished. The galley and pantry arrangements are very extensive.

Accommodation is fitted on the shelter, upper and main decks for 600 third class passengers, principally in two and four-berth staterooms. Separate dining saloons and recreation rooms are fitted for this class, and a special feature has been made of their lavatory accommodation, which includes baths and wash basins, supplied with both hot and cold water.

While primarily intended for passenger trade the *Letitia* will carry a large cargo. There are five holds, served by ten derricks and ten steam winches. The steering gear is of the Wilson & Pirrie type, controlled by a telemotor. An extensive installation of electric light has been provided, and electric fans and bells are fitted throughout. Refrigerating chambers are provided for the ship's provisions and cargo, the plant being on the CO_2 system. A system of wireless telegraphy will also be installed.

The machinery, constructed by the builders, consists of two sets of triple-expansion engines. The propelling machinery has been built to Board of Trade and Lloyd's special survey. Six single-ended boilers, each having three Morison suspension furnaces and working under natural draft, supply steam to two sets of three-cylinder, triple-expansion engines, driving two screws. The high-pressure cylinder is 26 inches diameter, the intermediate 43½ inches diameter and the low-pressure 72½ inches diameter—all of 48 inches stroke. Piston valves control the steam to the high-pressure cylinders. Andrews' valves are fitted to the medium-pressure cylinders, and double ported slides to the low-pressure cylinders. The columns and bedplates are of substantial box section.

The condensers, circular in form, are carried on seatings from the tank top, and are supported by brackets from the backs of high-pressure and medium-pressure columns. Ample cooling surface is provided to maintain high vacua. Working in conjunction with the condensers are air pumps of the Edwards design. Independent centrifugal pumps supply the necessary cooling water.

A steam reversing engine of the all-round type and a steam turning engine are fitted to each main engine. The thrust and propeller shafting is of forged steel, the propellers are about 17 feet diameter and of the built type, the bosses being of cast iron and blades of bronze. There is an auxiliary condenser and a full equipment of auxiliary machinery to ensure the safe and economical working of the vessel and the comfort of passengers. For the disposal of ashes from the boilers two of Crompton's silent ash hoists, with the necessary chutes, have been installed. Duplicate sets of electric generating machinery supply current for the lighting of the vessel and power for cabin and saloon ventilating fans, etc.

Alaska Steamship Company's New Steamship Cordova

The steel screw steamship *Cordova,* built by the Harlan & Hollingsworth Corporation, of Wilmington, Del., for the Alaska Steamship Company, of Seattle, Wash., was constructed for passenger and freight service. She is 251 feet long aver all, 243 feet 3 inches between perpendiculars, 41 feet beam, 20 feet depth to main deck, and 30 feet to bridge deck. The vessel is built of steel and equal to Lloyd's requirements. The double bottom is on the cellular system with floors on every frame. The framing above the tank is reinforced by web frames, beams are fitted to every frame, and the main deck is completely covered with steel. The pillars are of H-section, and are fitted with wood to prevent damaging the cargo.

The vessel has a forecastle, bridge and poop, the latter being a continuation of the bridge but at 2 feet less height. These erections cover 75 percent of vessel's entire length. Large watertight doors are fitted at the forward end of the bridge, so that freight may be stowed under the bridge and poop.

PASSENGER AND FREIGHT STEAMSHIP CORDOVA

The double bottom is constructed for carrying oil fuel, fresh water being carried in the tank under the engines and in the after peak. The vessel is divided transversely by four watertight bulkheads; she has two holds, served by two large hatches, 28 feet by 14 feet, on the main deck and one on the poop deck, the former strongly constructed and pillared so that heavy ore may be carried on top their covers.

The vessel is rigged as a two-masted schooner, the masts being of steel. Each mast carries two booms, each of which is capable of lifting 7 tons, also one boom designed and rigged for 20-ton lifts. These booms are of wood and stepped on a platform attached to the mast. The foremast carries a cross-yard and square sail, also a leg-o'-mutton sail, and the mainmast is rigged with storm sail. The mast and boom rigging is exceptionally heavy, all shrouds, stays and cargo running gear being steel wire with blocks of Boston and Lockport make in steel shells. Chain lashings with turnbuckles and slip hooks are provided in the forward well, so the vessel may carry a deck load of lumber if required.

Two powerful winches are fitted at each mast; they are of the vertical type, as manufactured by the Union Iron Works Company, of San Francisco.

The vessel is fitted with a steam windlass, steam warping capstan and steam steering engine, all of Hyde type. The steering engine operates a pinion through a friction device which absorbs all shocks, the pinion meshes directly with a geared quadrant on the rudder stock. The hand-steering gear operates the quadrant in a similar manner. A powerful towing engine is located in a house on the poop deck. This machine is of the Shaw-Speigle type, built by the American Engineering Company, better known as Williamson Bros.

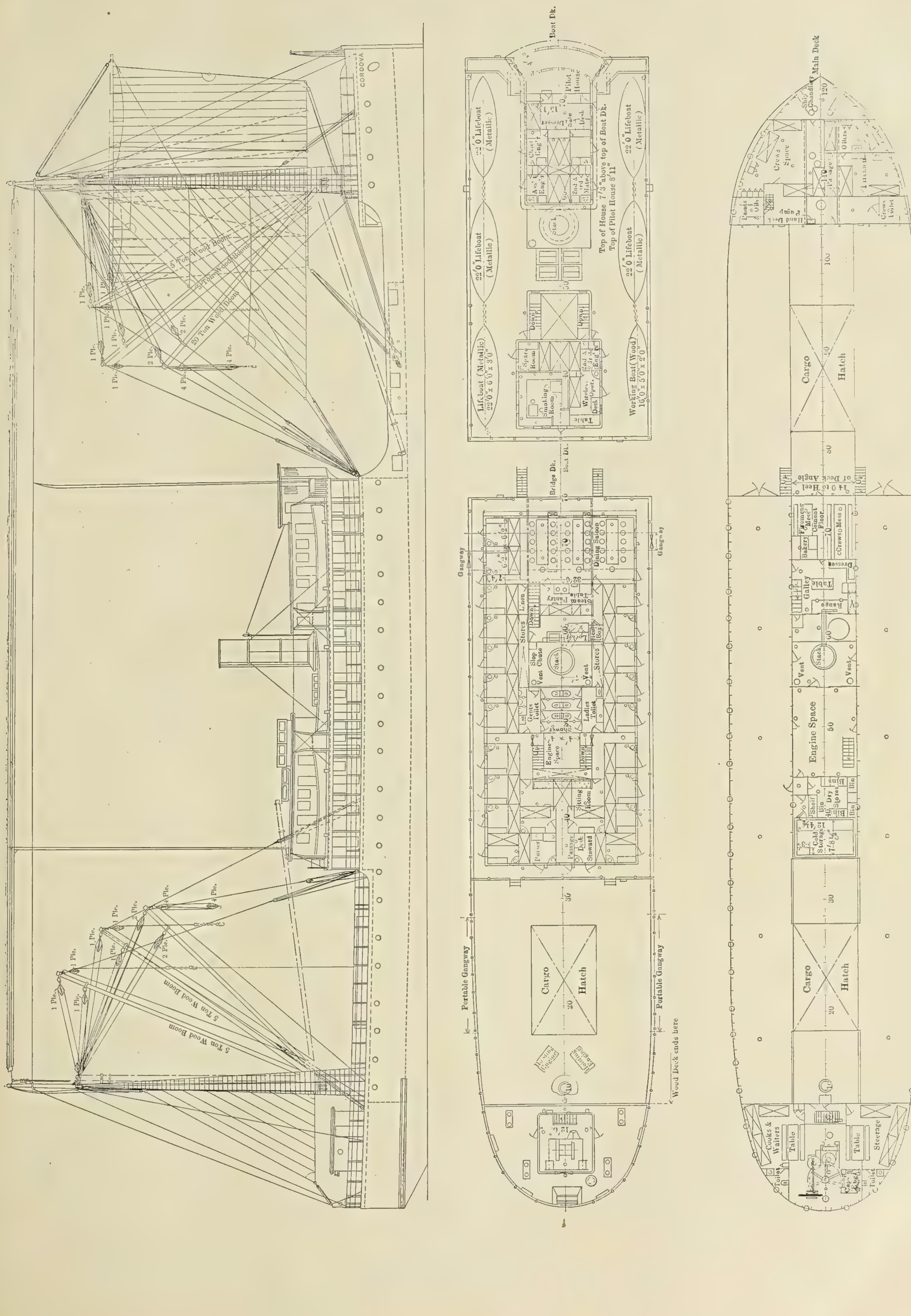
The crew are housed in the forecastle, the steerage and waiters are in the after end of the poop, metal beds and lockers being provided for their use. The galley, messroom, storerooms and cold-storage rooms are in the center house forward and abaft the machinery space below the bridge deck. A 1-ton refrigerating plant of Vulcan Iron Works make is installed for provisions and supplying ice water.

The passenger accommodation is in a house built on the bridge deck, at the forward end of which is the dining saloon, with the pantry abaft same, the latter having communication with the galley by a stairway and dumb waiter. All of the staterooms, with the exception of two, are outside rooms having outside doors; there are three berths in each room and all the furniture is of oak. Each stateroom is furnished with the usual wash bowl, mirror, toilet rack and steam radiator. The toilet rooms are located between the engine and boiler hatches, each being fitted with a shower bath, wash basins and tiled floor. These toilets are lighted and ventilated by overhead skylights. A small sitting room is provided for passengers on this deck, and a smoking room, finished in plain oak, is located on the boat deck, access to which is obtained by metal stairways. The bridge and poop decks are sheathed with heavy pine and form a splendid promenade for passengers.

The vessel is fitted with a wireless telegraph apparatus, the operator's room and office being located alongside the smoking room.

The officers' quarters are in the deck house at the forward end of the boat deck and immediately abaft the pilot house. These rooms are finished in oak. The captain's room is paneled in oak, and has a door opening into the pilot house. The pilot house is protected by a covered-in navigating bridge, on which the engine room telegraphs are placed; this navigating bridge is carried out to the sides of the ship, and is 2 feet above the boat deck, but level with the pilot house floor. A standard compass and searchlight are placed on top of the pilot house.

The vessel has one triple-expansion, surface-condensing engine, with cylinders 19 inches, 30 inches, 50 inches diameter and a stroke of 36 inches. The high-pressure and intermediate-pressure cylinders have piston valves, while the low-pressure cylinder has a double-ported slide valve. The condenser is built in with the frame of the engine. The valve gear is of the Stephenson link type. A steam reversing gear is installed and water circulation is provided for all bearings. The air pump and two bilge pumps are attached to the back of the condenser. The independent pumps, made by the Fairbanks-Morse Company, are the main and auxiliary feed pumps, donkey and fire



OUTBOARD PROFILE AND DECK PLANS OF THE CORDOVA

pump, bilge and deck pump, sanitary, salt-water and fresh-water pumps. The circulating pump and engine were constructed by the builders of the vessel and her machinery. A 12-ton capacity evaporator is installed for making up fresh water losses, also a vertical multi-coil feed-water heater, both of Griscom-Spencer Company make.

The vessel has two main single-ended Scotch boilers, 12 feet diameter by 11 feet 6 inches long, each boiler having three furnaces. The steam pressure is 180 pounds per square inch. A vertical donkey boiler, 4 feet 6 inches diameter by 9 feet high, is located on the main deck. Settling tanks are built in the boiler room in connection with the fuel oil system; one oil tank pump and two oil fuel pumps are installed. The system of supplying oil to the furnaces for combustion and the arrangement of burners is such that no steam or compressed air is required for atomizing the oil, and is known as the Dahl's patent oil-burning system, as manufactured by the Union Iron Works, of San Francisco.

The vessel is lighted throughout by electricity, two generators, one of 13 kilowatts and one of 6.6 kilowatts capacity, being installed, and each direct connected to a De Laval steam turbine engine.

This vessel can carry 1,930 long tons cargo, 4,038 barrels of fuel oil and 100 tons of fresh water on a draft of 18 feet. She has accommodations for seventy first class and nine steerage passengers and carries a crew of thirty.

Five metal lifeboats and one working boat are placed on the boat deck with an efficient device for lowering same. The vessel is fully equipped for service to pass the United States inspection for fire-fighting, navigating and life-saving apparatus. Her gross tonnage is 2,273.50, net 1,406, the official number 209,655, signal letters L. C. H. P. On trial with ballast tanks full the vessel made a mean speed of 12 knots and developed 1,200 indicated horsepower. She is expected to make about 10 knots when loaded in service.

Sea-Going Tugs Sonoma and Ontario

Two single-screw, seagoing tugs, *Sonoma* and *Ontario*, are at present being completed by the New York Shipbuilding Company, at Camden, N. J., for the United States navy. Each vessel is of the following dimensions:

Length over all	185 feet 2 inches.
Length between perpendiculars (fore side of stem to after side of rudder post)	175 feet.
Beam, molded	34 feet.
Beam over guards	35 feet 6 inches.
Depth, molded, to main deck	20 feet 3 inches.
Mean load draft (salt water)	12 feet 6 inches.
Speed, loaded, at sea	14 knots.

The vessels are of open-hearth steel throughout, and built in accordance with the rules of the American Bureau of Shipping and under special survey. Each vessel is subdivided by seven watertight bulkheads, and has a raked stem and elliptical stern, two masts, with a derrick boom of 5 tons capacity on the foremast, schooner rig and a wireless outfit. These tugs are very large and powerful, being well adapted for the work they would be called upon to do in the event of war.

Quarters for a naval complement of four officers, three chief petty officers and thirty-five men are provided for.

There is fitted forward a steam windlass, combined with a towing bitt, the windlass having warping ends. A reversible capstan is fitted on the main deck aft. Two steam winches of 5 tons capacity each are located, one at the foremast on the main deck, the other at the main mast on top of the deck house. A towing machine is provided in the after end of the main deck house and supplied with necessary hawser rollers, etc.; a towing bitt is also fitted aft.

The steam steering engine is located in the engine room, and is connected with the pilot house; a combined steam and hand-steering wheel is fitted on the after end of the deck-house top. The vessel's boats consist of one 21-foot motor dory, one 28-foot whale boat and one 16-foot dinghy, the former two being slung under davits. One 4-inch Monitor fire hose nozzle is fitted on top of the pilot house and a similar one on top of the deck house aft. A machine shop, amply equipped, is located upon a platform on the port side of the engine room.

A double bottom and feed-water tanks are fitted under the boilers. Peak tanks are arranged for the carrying of fresh or salt water. The coal bunkers are abreast of the boiler room, and a cross-bunker is aft of the boiler room. The drinking water tanks contain 4,000 gallons of fresh water, and there is a gravity tank of 500 gallons. Refrigerator space is provided with a capacity of 550 cubic feet.

The propelling machinery is placed amidships, and consists of two single-ended Scotch boilers, arranged fore and aft, with the fire-room between the two. They are 16 feet in diameter and 11 feet between heads, with a working pressure of 200 pounds per square inch. The main engine is of the vertical, inverted cylinder, triple-expansion, surface-condensing type, of about 1,800 horsepower, with cylinders 19¾, 31½ and 54¼ inches diameter, respectively, with a common stroke of 36 inches.

New Steamship for Australian Service

The *Dimboola*, which was launched from the Neptune works of Swan, Hunter & Wigham Richardson, Ltd., on May 3, is being built to the order of the Melbourne Steamship Company, Ltd., of Melbourne, Australia, being intended for their passenger and cargo service on the southeast, south and west coasts of Australia. She will run between Sydney, New South Wales, and Geraldton, West Australia, calling at various intermediate ports, and she is expected to take about four weeks for the round trip.

The *Dimboola* is a finely proportioned steel steamer, 360 feet in length by 50 feet beam by 34 feet deep, with forecastle and poop and bridge combined. She is fitted with a double bottom all fore and aft. The propelling machinery will consist of a set of quadruple-expansion engines, which, with the boilers, are being constructed at the Neptune works. There is a fine promenade deck amidships, with a house containing the first class music room and staterooms for twelve first class passengers. Below this, on the bridge deck amidships, is the first class dining saloon, a handsome room, which will have seating accommodation for about sixty passengers. On the same deck near at hand are staterooms for sixty first class passengers. Close to these is a very comfortable smoking room for first class passengers. On the same deck, aft, the second class passengers have their dining saloon and a smoke room, while below are staterooms for seventy-four second class passengers.

As the carriage of cattle is an important feature in the trade for which this vessel is designed, space is arranged on the upper deck to carry about 150 head of cattle, while there are rooms for stockmen in attendance. The cargo arrangements are very complete, and the gear includes four steam cranes, three steam winches, a derrick for lifting specially heavy loads, etc. As the vessel will frequently be trading in very hot climates, special attention is paid to the ventilation of all spaces, and there is a refrigerating engine and insulated rooms.

Russian High-Speed Marine Diesel Engines

BY J. RENDELL WILSON

After the revelations, first made in the January issue of this journal, of the progress made with the installation of big Diesel engines in ships in Russia, it will not perhaps be a surprise to learn that the Maschinenfabriek Ludwig Nobel, of St. Petersburg, has perfected the high-speed, lightweight marine oil engine of this type, and we are again enabled to be the first to give some interesting illustrations and full details of a vertical Diesel engine of 180 brake-horsepower that weighs but 33 pounds per horsepower.

It is extremely unlikely that any other concern can claim the experience that Nobels have had in this direction, as during the last eight years the marine engines constructed by them aggregate 20,000 horsepower, while at the time of writing they have another 20,000-horsepower going through the shops, a be the means of securing an unheard-of speed for torpedo boats, despatch boats and destroyers with perfect safety, as the fuel used is residue oil. Although for a Diesel engine, the running speed (450 revolutions per minute) is certainly on the high side, it is by no means impractical, and to obtain the same power for the cylinder bore and stroke a gasoline (petrol) engine would have to turn much faster, resulting in excessive piston speed. Again, the engine which I propose to describe first is only 9 feet long over all by 4 feet 9 inches high, or about the size and weight of an ordinary 50-horsepower marine kerosene (paraffin) engine and reverse gear, although nearly four times that horsepower is obtained, while the fuel consumption is nearly one-half. A very noteworthy and important fact.

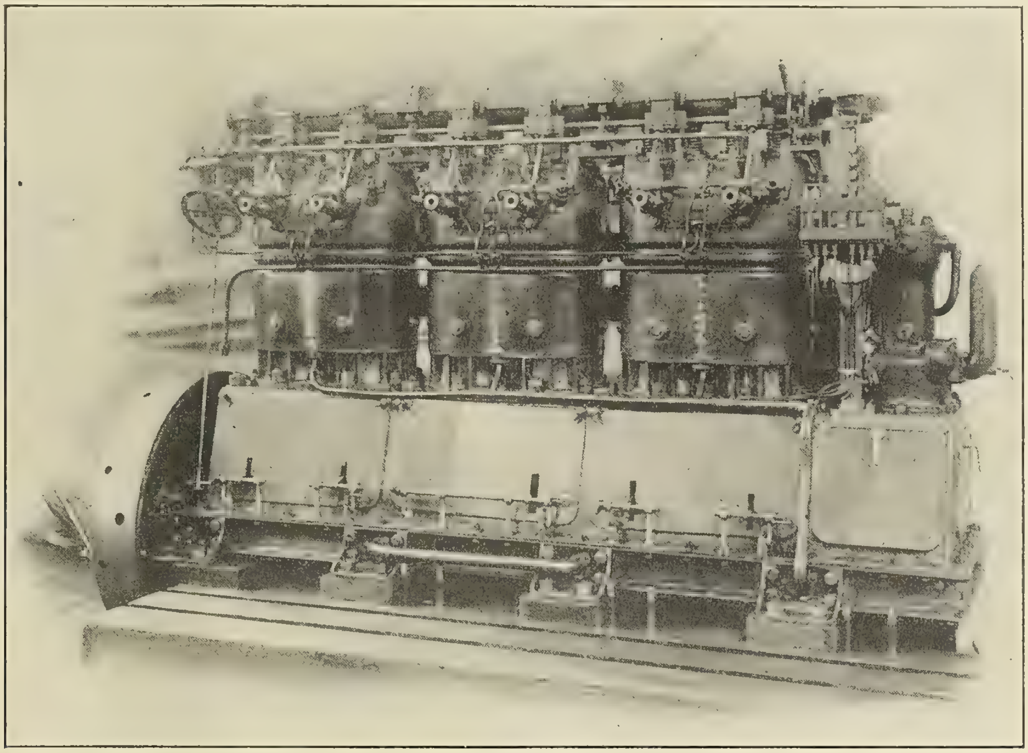


FIG. 1.—LUDWIG NOBEL 180-BRAKE-HORSEPOWER HIGH-SPEED MARINE DIESEL ENGINE

large number of which have been ordered by Nobel Bros. Naphtha Company, the great oil firm. Altogether the number of Diesel engines, including land types actually supplied in thirteen years, is 500, aggregating 60,000 horsepower. With the marine sets their experience covers many types of vessels, including yachts, submarines, tugboats, passenger, mail, cargo and tankships, also six 1,000 brake-horsepower gunboats, while by the time these words are in print the engines for a Russian revenue cruiser will have been accepted, the trials of which were run during May at Nicolieff. The largest single engine yet installed is of only 1,000 horsepower, but, unfortunately, no details of this vessel and machinery are obtainable. It was six years ago that they completed their first reversible Diesel engine. Vessels engined by them previous to this date were used in conjunction with electric or pneumatic clutches and special reversing gears.

The perfection of the lightweight heavy oil engine is by no means a small achievement, and there is no limit for the development, especially for naval work, and it may eventually

Figs. 1, 2 and 3 are illustrations of a six-cylinder non-reversible Nobel-Diesel marine engine of the four-cycle, single-acting vertical type, developing 180 horsepower at 450 revolutions per minute. Light weight is obtained by adopting an aluminum crankcase, and fitting sheet copper water-jackets to the cylinders, and by carefully designing every feature to obtain a minimum of size without sacrificing strength where such is required. Consequently the weight, with flywheel, is but 2 tons 13 cwts., that is to say, 33 pounds per horsepower, which is certainly a record in the history of the vertical Diesel engine. When one considers that the engine is of the four-cycle type, and that only one power impulse per cylinder is obtained every two revolutions the result is remarkable. There are six working cylinders, cast in pairs, each having a bore of 9 inches and 12 inches stroke, so that each cylinder gives over 68 horsepower for every *combustion stroke*, and, of course, half that figure every revolution. Fig. 3 is a drawing of this engine, while Fig. 2 depicts the valve arrangements on the cylinder heads.

At the forward end is a two-stage air compressor for providing the air for starting, reversing and fuel injection. This compressor forms an extension of the engine, and is driven off the crankshaft by a connecting rod. Mounted on the cylinder heads and running lengthwise is a camshaft (enclosed in an aluminum casing), which is operated by bevel gearing from a vertical spindle arranged between the forward cylinder and compressor, the drive from the crankshaft also being by bevel gearing. All the valves, with the exception of the fuel injection and air-starting valves, are actuated directly by the cams, the usual rocker arms being dispensed with, thus saving considerable weight. The fuel injection valve, it will be noted, is mounted on the starboard side of the

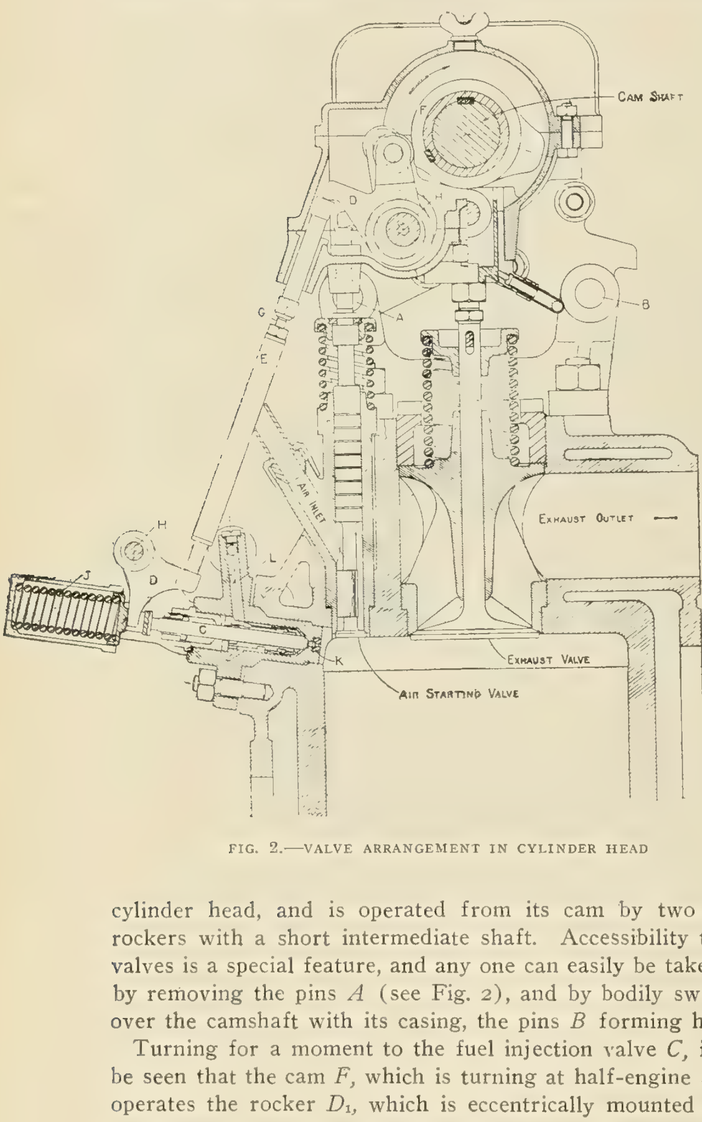


FIG. 2.—VALVE ARRANGEMENT IN CYLINDER HEAD

cylinder head, and is operated from its cam by two small rockers with a short intermediate shaft. Accessibility to the valves is a special feature, and any one can easily be taken out by removing the pins *A* (see Fig. 2), and by bodily swinging over the camshaft with its casing, the pins *B* forming hinges.

Turning for a moment to the fuel injection valve *C*, it will be seen that the cam *F*, which is turning at half-engine speed, operates the rocker D_1, which is eccentrically mounted at *H*, and the movement is transmitted by the rod *E* to the rocker *D*, which is mounted on a fulcrum at H_1. This rocker opens the fuel valve *C*, which shuts by the powerful spring *J*, air first blowing in the fuel at *K*, it being admitted at *L*. The rod *E* is adjustable at *G;* thus the lift of the fuel valve can easily be regulated.

The working action of the engine is as follows: For starting, air is admitted under pressure from a steel storage bottle to the cylinder, the piston of which has just passed the dead-center, and is commencing the down-stroke. This gives sufficient turning impetus for the other cylinders to come into play in turn; starting air is then, of course, shut off, the rocker operating the valve being mounted on an eccentric fulcrum, so is easily lifted clear of the cam by a hand lever. On the down-stroke of the piston that first picks up the load, air is drawn through a mushroom valve, via a silencing box, and on the up-stroke is compressed to 525 pounds per square inch. Just as the piston reaches the top of the compression stroke the fuel valve opens, and the oil (specific gravity 0.8 to 0.9) is injected by air blast from the high-stage compressor at 1,050 pounds per square inch. Combustion is instantaneous, and the next up-stroke is the exhaust. This cycle of operations is continually repeated with all cylinders as they pick up the load. Taking the cylinder compression into consideration the pressure used for fuel injection is unusally high. But this ensures the fuel being well sprayed across the combustion chamber for the purpose of perfect combustion. Thus the efficiency is very high, and the fuel consumption, I understand, ranges from 0.41 to 0.45 pound per brake-horsepower per hour, being exceptionally low figures. Control of the air and fuel valves is by a hand-wheel.

There are no cross-heads and guides, as the trunk type of piston has been adopted and the pistons are of ample length to take up the side thrust. Very large doors are provided to the crank case through which the pistons and connecting rods can be withdrawn and the main bearings examined. The fuel pumps, of which there are three, one for each pair of cylinders, are of the plunger type. They are mounted on the head of the after cylinder, and are driven by eccentrics on a lay shaft, which is operated by pinions from the overhead camshaft. They are controlled by a centrifugal governor arranged in the flywheel. From each fuel pump the fuel pipe is led to a small distributing valve on each pair of cylinders which can be regulated by hand. Both lubricating and water-cooling arrangements are very complete, even the crank-case sump from which the oil is pumped being water-cooled. Before passing to the working parts the lubricating oil first passes to eight adjustable sight-fed lubricators arranged at the forward end of the engine. Another minor detail is that the camshaft is equipped with ball-bearing thrusts. This engine, of course, is more suitable for yachts rather than for commercial vessels. In fact, Mr. Ludwig Nobel has had two high-speed, 350-horsepower engines of the two-cycle type, but with open crank pits, installed in his new 120-foot yacht, with the result that a speed of 20 knots has been obtained.

I am also enabled to include some interesting illustrations of an 8-cylinder V-type Diesel engine (Figs. 5 and 6), developing 150 horsepower at 500 revolutions per minute, which has been driving Mr. Nobel's yacht *Intermezzo* for several years. The owner tells me that this engine has run at a much higher speed than its normal rate. He uses the yacht on the Neva, and she is 56½ feet long by 8 feet 3 inches beam, with 3 feet 10 inches draft on a displacement of 10 tons, and has a speed of 15 knots. Unlike the engine just described this particular model is reversible, reversing being carried out by longitudinally moving the cam-shaft by means of a hand lever at the forward end, which brings another set of cams into action. At the same time the small hand-wheel, arranged at the side of the lever, is turned, which shuts off the fuel and admits compressed air to the pistons on the up-stroke, turning the crankshaft in the reverse direction. Another slight turn of the hand-wheel shuts the air valve and opens the fuel valve, allowing all cylinders to pick up the load. It will be noted that the cam-shaft is arranged in the apex of the V formed by the junction of the cylinders, from which the valves in the cylinder heads are operated by means of push rods and rockers. As there are four valves to each cylinder, the cam-shaft, which is driven by gearing from the crankshaft at the after end, has to operate no fewer than thirty-two valves. The cylinders have sheet copper water-jackets, and the crank-case and valve casing are both of aluminum. Admission to the crank-case is by a large door at the forward end and by a series of small removable plates just under the

cam-shaft, which is raised clear of the crank-case, being supported by five strong aluminum brackets.

To all appearances there are ten cylinders, but the fifth cylinder on each side at the forward end is an air compressor, the low stage being on the starboard (left side of illustration) and the high stage to the port side. The low-pressure air is utilized for starting and reversing, while the high-pressure air is for fuel injection. Each cylinder has a bore of 8 inches by 8½ inches stroke, and every pair is arranged facing, the connecting rod of the one cylinder being forked to receive the other; thus every throw of the crank-shaft, with its big end, is sufficient for two cylinders. The pistons are of the trunk type. A water-cooled silencer is arranged along each side gines just described. Working on the four-stroke principle it has four cylinders, cast in pairs, and develops 125 brake-horsepower at 450 revolutions per minute. In this case the metal used for the cylinders and crank-case is cast iron, and an engine of this type seems suitable for tugs, fishing vessels, vedette boats or small cargo craft. The flywheel, too, is much larger and heavier than with the lightweight motors. Its overall length, including flywheel, is 7 feet 6 inches, and its height is 4 feet 8 inches from the center of the crankshaft. All the valves are arranged on the cylinder heads, although the fuel-injection valves are on the starboard side of the cylinder heads. They are operated by rockers and long push-rods from a cam-shaft, which is arranged on the crank-case at the star-

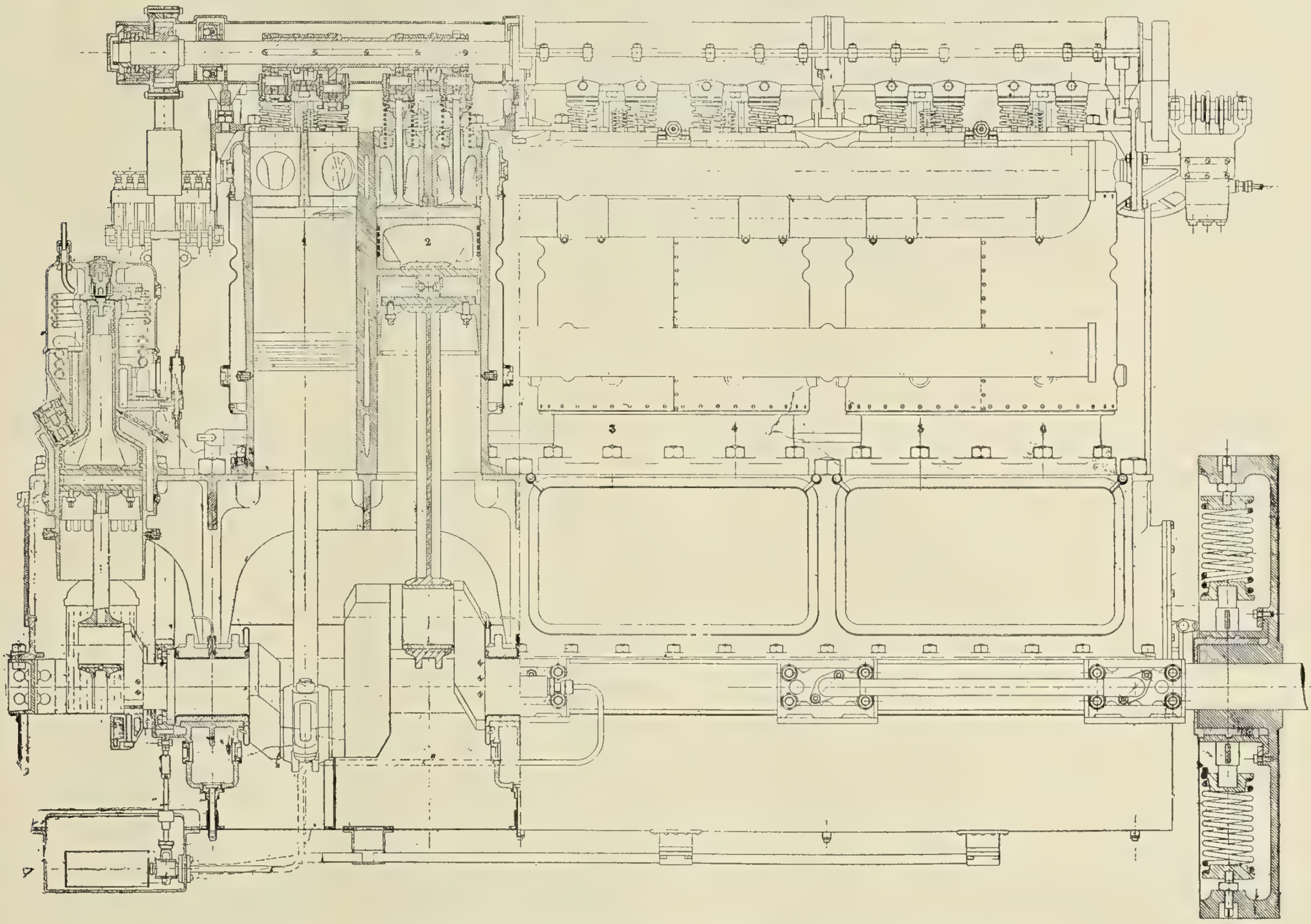


FIG. 3.—SECTIONAL DRAWING OF SIX-CYLINDER 180-HORSEPOWER NOBEL-DIESEL ENGINE

of the crank-case. At the forward end, by the control levers, is mounted a sight-feed lubricator, there being fifteen force-fed oil drips, which are carried to the chief working parts. The weight of this engine is even more noteworthy than the vertical model just described, but from the general design this may be expected. Its total weight, with flywheel and compressors, is but 2 tons; that is to say, 30 pounds per brake-horsepower; certainly an extraordinarily low figure, considering that the engine is directly reversible. The figure is such that the engine should give excellent results in a racing boat, despite the fact a fairly large propeller would be required; also, it must be remembered that this engine can maintain a much higher turning speed if necessary, while I understand that it will run smoothly at 200 revolutions per minute—not an inconsiderable radius.

Let us now turn to Fig. 4. This engine is also of the high-speed Diesel type, but of slightly heavier build than the en- board side. The cam-shaft itself is driven by enclosed gearing from the crank-shaft at the after end, while the two-stage compressor is driven direct off the crank-shaft at the forward end. It is interesting to note that the cam-shaft serves four purposes in addition to operating the four valves to each cylinder. Between the two pairs of cylinders are four fuel pumps of the plunger type, one to each cylinder, and these are operated by eccentrics on the cam-shaft. At the after end the cam-shaft actuates a centrifugal governor which is connected to the fuel pumps by a steel rod, and when the engine-speed is excessive shuts off the fuel supply. At the forward end of the cam-shaft is operated a set of five plunger lubricating pumps, also a large rotary water-circulating pump. The two levers on the cylinder heads are apparently for raising the rollers of the rockers operating the fuel and inlet valves clear of the tappets when reversing. In this case these rockers must be mounted on eccentric fulcrums. The lever for bodily

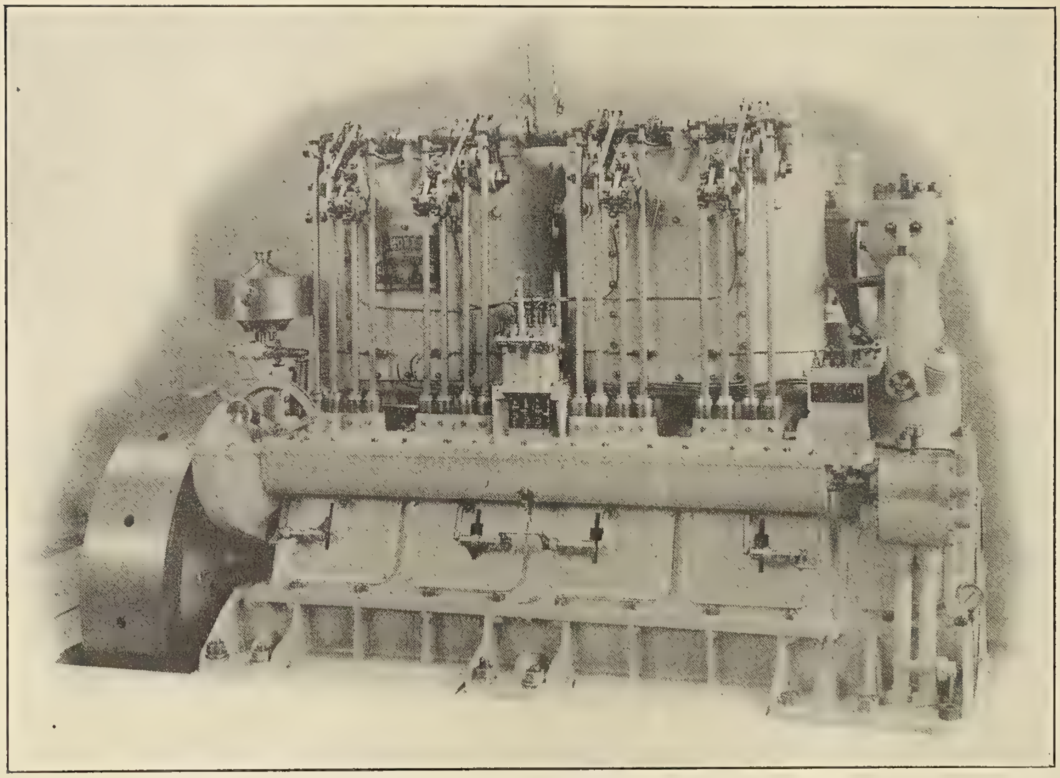


FIG. 4.—125-BRAKE-HORSEPOWER FOUR-CYLINDER DIESEL ENGINE. 450 REVOLUTIONS PER MINUTE

shifting the cam-shaft for reversing can be seen at the after end; the action of moving the cam-shaft brings, of course, another set of cams into action. With this engine the trunk-type of piston has also been adopted.

Editorial Note:—Owing to the difficulties of translating from the Russian language it is possible that one or two slight errors—not necessarily the author's—may have crept in, but Mr. Wilson has paid the greatest attention to the accuracy of the figures quoted. On account of the vast resources of petroleum in Russia it is not strange that the engineers of that country should be among the pioneers in the development of this type of engine.

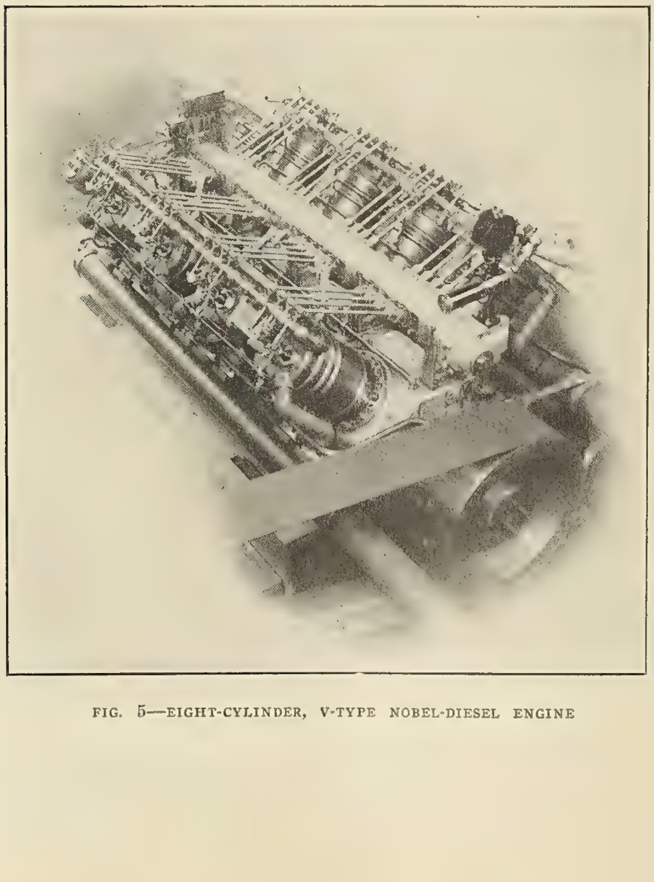


FIG. 5—EIGHT-CYLINDER, V-TYPE NOBEL-DIESEL ENGINE

The Robert Muser

A side-wheel, shallow-draft towboat, which is said to be the most powerful tug on the River Rhine, was built some time ago by Messrs. Gebr. Sachensberg, Rosslau (Elbe), for the Harpen Collieries, Mudheim, Ruhr. The vessel is 246 feet long, 68.8 feet beam, with a depth of 4.3 feet. The machinery consists of one triple-expansion engine, capable of developing about 2,000 horsepower. This vessel was christened the *Robert Müser*. Under ordinary circumstances the boat carries a tow of from four to six barges, with a total capacity of about 6,500 tons, up the river against the current. The boat was built especially for the coal-carrying trade on the middle and upper reaches of the Rhine between Duisberg and Mannheim. After the steamer was completed she made the voyage from the Elbe to the Rhine under her own steam, and, in spite of encountering very rough water, she showed admirable qualities, and arrived at Rotterdam without damage.

THE MOST POWERFUL SIDE-WHEEL TUG ON THE RHINE

The Bureau of Navigation reports 269 sailing, steam and unrigged vessels of 35,302 gross tons built in the United States and officially numbered during the month of May, 1912. Of the steel steamers, six, aggregating 7,308 gross tons, were built on the Atlantic and Gulf coasts, and four, aggregating 9,047 gross tons, were built on the Great Lakes.

The Diesel Engine—Its Application to Ship Propulsion*

BY DR. RUDOLF DIESEL

There have been so many articles published recently, and especially during the past year, in technical periodicals of all languages, on the construction of the Diesel engine and its various types, that it is hardly possible to give any fresh information on the subject. The author, therefore, proposes to admit as generally known the working principle and the construction of his engine and to discuss only questions of general importance.

Efficiency

Since its first appearance in 1897 the Diesel engine has been built by the thousands in the best factories of all industrial countries, and has been set up in the most remote corners of the world. It has proved to be a most reliable engine when properly built, and to-day the thermal or indicated efficiency reaches 48 percent in this engine, and the effective or brake efficiency reaches, in some cases, 35 percent of the heat value of the fuel.

The Diesel engine is the only engine which converts the heat of the natural fuel into work in the cylinder itself without any previous transforming process, and which utilizes it as completely as the present advancement of science permits; it is, therefore, the simplest, and at the same time the most economical, prime mover. These two facts explain the success of the Diesel principle, which lies in the new method of the internal working process and not in constructional improvements of older types of engine.

A further reason for this success is that the Diesel engine has broken the monopoly of coal and has solved the problem of using liquid fuel for power production in its simplest and most general form. It has become for all liquid fuels what the steam engine and gas engine are for coal, but in a much simpler and more economical way. The truth of this statement was strikingly proven at the Turin Exhibition of last year. At this Exhibition, in the large Machinery Hall, a steam turbine and a large Diesel engine, both made by Franco Tosi, of Milan, and set up on the same stand, were worked together with the same liquid fuel. The boilers of the steam plant were fitted with Koerting nozzles for burning crude oil.

The difference between the two plants was, therefore, this: For the working of the steam engine the complete boiler plant, with its chimney, fuel supply apparatus, purification plant for feed water, with feed pumps, extensive steam pipes, condensation plant with water pumps and an enormous quantity of water, had to be provided, with the final result of consuming two and one-half or more times the fuel per horsepower required by the Diesel engine standing beside it. The latter, being an entirely self-contained engine without any auxiliary plant, took up its crude fuel automatically and consumed it direct in its cylinders without any residue or smoke.

Fuel

Thus the Diesel engine has doubled the resources of mankind as regards power production, and has made new and hitherto unutilized products of Nature available for motor power. The Diesel engine has thereby exercised a far-reaching influence on the liquid fuel industry, which is at the present time improving more rapidly than was previously conceivable. It has been proved by recent geological researches, not only that there is probably on the globe as much, or perhaps even more, liquid fuel than coal, but also that it is more conveniently distributed as regards its geographical position. That the auxiliary industries of petroleum production are also considerably influenced, is shown by the great increase which the transport industry for liquid fuel has experienced in recent times, especially the great development of tank vessels, which are, or will be, mostly driven by Diesel engines.

But with all this, the influence of the Diesel engine in the world's industries is not exhausted. As early as the year 1899 the author utilized in his experimental engine the by-products of coal distillation and coke plants, such as tar and creosote oils, with the same satisfactory results as with natural liquid fuels; but at that time the quality of these oils was generally too inferior for their use in the Diesel engine, and it was, moreover, subject to continual variation. It is only in recent years that the chemical industries interested in the matter have, by improved methods of fractioning and refining, combined with more careful selection of the material, succeeded in supplying fuel of a constant and regular quality without the drawbacks of the crude tar oil used previously. These products—the tar and tar oil—are thus, to-day, definitely brought into the sphere of activity of the Diesel engine. This fact is, perhaps, not of so great an importance to the United States on account of its richness in natural oil, but it is of the utmost importance for European countries, and especially for those countries which do not have an oil production of their own; and it may be of some interest to state that, for instance, the tar production of Germany is sufficient for more than five billions of horsepower-hours per year, which means about one and three-quarter millions of horsepower running three hundred days, ten hours each, all the year. In case of war and the consequent cutting off of the supply of foreign fuel, this quantity would be sufficient for running the whole fleet, war and mercantile, and for providing in the meantime the power for the inland industries as far as necessary.

One fact stands out clearly in this connection—namely, that coal, which seemed to be most threatened by the liquid fuels, will, on the contrary, gain a new and wider ground of application through the Diesel engine. As tar and tar oils are from three to five times better utilized in the Diesel engine than coal in the steam engine, a much better and more economical utilization of coal is obtained if, instead of being burned under boilers on grates in a wasteful way, it is first transformed into coke and tar by distillation. Coke is used for metallurgical and other general heating purposes; from the tar the valuable by-products are first extracted and undergo further processes in the chemical industry, while the tar oils, the combustible by-products and a large part of the tar itself are burned in the Diesel engine under extraordinarily favorable conditions.

It is evident that these circumstances are of different importance and value in different countries. Some are exclusive coal-producing countries, others exclusive oil-producing countries, and still others produce coal and oil, like the United States. It is difficult to predict what development will take place in a given country, but it is certain that the possibility of burning the by-products of gas works and coke ovens in the Diesel engine has had in Europe the effect of making the different countries independent for their supply of liquid fuels, in preventing the increase of prices for the natural liquid fuels and the establishment of trust or monopoly companies. This condition has been reached in Europe.

From what has been said the following statement may be made: The proper development of the utilization of fuel

*Abstract of a paper on "The Present Status of the Diesel Engine in Europe and a Few Reminiscences of the Pioneer Work in America," read before the American Society of Mechanical Engineers, New York, April, 1912.

which has already been started and is now making rapid progress, comprises, on the one hand, liquid fuel in Diesel engines, and, on the other hand, gas fuel, in the form of gasified coke, in the gas engines; solid fuel, as little as possible, for power generation, but as much as possible in the refined form of coke for all other heating and metallurgical purposes.

It is not generally known that it is also possible to burn vegetable oils and animal oils in the Diesel engine without any difficulty. The author made the first trials with earth-nut oil (botanical name, Arachis hypogæa—an oil which is extensively obtained from a plant growing abundantly in the tropical wildernesses of Africa) at the Paris Exhibition in 1900, and has since then repeated them with castor oil and palm oil and also with animal oils. The use of vegetable oils may seem insignificant to-day, but such oils may become in course of time as equally important as some natural mineral oils and the tar products are at the present time. One cannot tell what part these oils will play in the colonies of the future. In any case, they make it certain that motor power can still be produced from the heat of the sun, which is always available for agricultural purposes, even when all our natural stores of solid and liquid fuels are exhausted.

Marine Engines

The first Diesel marine engine was constructed in 1902 to 1903 in France, for use on a canal boat, by the French engineers Adrian Bochet and Fréderic Dyckhoff, in conjunction with the author. This engine had two pistons working in opposite directions and one cylinder, and worked on a four-stroke cycle. The great feature of this arrangement was the very high speed which was made possible by the perfect balance. This small engine was, as stated, used to drive a canal boat, and worked quite satisfactorily. Others were also built in various sizes up to several hundreds of horsepower for some French submarines by Sautter, Harlé & Co., Paris.

This type of engine is of no further practical interest to-day, but it has at least the historical interest of being the first Diesel engine to be used on a boat. Since the time mentioned, the evolution of the Diesel marine engine has steadily continued, stimulated chiefly by the demand for French submarines and Russian river boats. The author has already mentioned that later on the high-speed, four-stroke cycle engine, built for electric power stations, were made even lighter than before and used for French submarines and for Russian river vessels. These engines were not originally reversible; on the contrary, they were used to generate electricity by means of which the propellers were driven indirectly for maneuvering. The first reversing marine two-stroke cycle Diesel engine was built in 1895 by Messrs. Sulzer Bros. at Winterthur. At that time engineers were not quite clear as to the importance and value of the two-stroke cycle principle, and many firms went on trying for years to make the four-stroke cycle reversible. The first engine of this kind was built by Messrs. Nobel Bros. at St. Petersburg in the year 1908 and was fitted to a Russian submarine.

In many factories reversible four-stroke cycle marine engines are still built; but, on the whole, engineers are, for navigation purposes, inclined to abandon the four-stroke cycle engine entirely and to replace it by the two-stroke cycle engine.

For larger sizes of ship engines, no standard type can be designated as yet. Each ship and each engine must be treated individually. Although several of the engines of Diesel liners are yet four-stroke engines, it appears unquestioned that the large ship engines will develop on a two-stroke type with cross-heads and with exactly the number of revolutions wanted by the propeller, and that there is a tendency to make these engines as nearly as possible to resemble steam engines, even in those points where it would not be necessary, because the marine people adopt new things very much easier when they look similar to that to which they are accustomed.

It is generally known that very important experimental work is being done in different places for the purpose of developing high-power marine engines with cylinder units reaching 1,000 to 2,000 horsepower or more. Some manufacturers solved this problem with double-acting, others with single-acting cylinders, but all on the two-stroke cycle. The M. A. N. is experimenting on a 6,000 horsepower, two-stroke, double-acting engine, with three cylinders of 2,000 horsepower each. Messrs. Sulzer Bros. are just erecting a single cylinder of 2,000 horsepower single-acting, based on a construction which permits an entirely free expansion of the cylinder under the action of the varying temperatures. Krupp's Germania Yards have a 2,000 horsepower cylinder double-acting on the testing stand. Vickers Sons & Maxim are experimenting on a large scale with the double-acting, two-stroke cycle type. A cylinder unit of 1,000 to 1,200 horsepower has been built by Messrs. Carels Frères for experimental purposes.

If, as seems probable, these tests give satisfactory results, the era of very large Diesel engines has come. For motives of prudence, the various navies which are now fitting some warships with Diesel engines started with one Diesel only out of the two or three engines on board; the Diesel works alone when the ship is cruising, but for high speed steam is used as an auxiliary. It is evident that large warships will not be fitted solely with Diesel engines until practical tests on the high seas have proved to be completely successful.

Vessels Propelled by Diesel Engines

The author has compiled from publications and private sources a complete list of Diesel engine propelled ships, built or in course of construction up to November, 1911, which shows a total aggregate of 365, and an analysis of which shows the following distribution:

Oil tank vessels	about 30
Tugs	about 40
Motor sailing vessels	about 10
Merchant vessels (freight, passenger and combined freight and passenger vessels)	about 50 to 60
Fishing boats	about 15
Submarines	about 140
Warships (small cruisers, gunboats, mine-laying boats, and the like)	about 40
Small marine craft	about 20
Miscellaneous vessels	about 20

In the following the author will give a brief historical review of Diesel engine ships and the results of trials and journeys as far as a record of them has been obtainable.

One of the very first small cargo boats on the Lake of Geneva was the *Venoge,* fitted with non-reversing engine driving the propeller electrically. The captain maneuvers the ship from his bridge entirely by electrical controllers. The motor runs below him without any engine man. Already this first boat shows the characteristic features of the Diesel ship—namely, the motor is as far back as possible, the funnel is absent, the deck quite clear, and the whole body free for cargo.

The passenger vessel *Uto,* on the Lake of Zurich, 200 tons displacement, 250 to 260 horsepower, has made regular passenger trips on Lake Zurich since the summer of 1909. It is a converted steamer. Weight of the previous steam plant, including coal and water, 14.46 tons for 64.6 sea-miles radius. Weight of the new plant, for double the power and 646 sea-miles radius, is 9.6 tons. Cost of fuel, one-fourth of the previous cost. Saving in labor, one man.

The German tug *Fortschritt*, in Hamburg harbor, is equipped with a 150 horsepower Diesel engine. It made very stormy voyages on the open sea and carried fuel for eight days. Gain in length one-third over a steamer. The gain in weight of machinery about one-fourth over steam plant. Weight of fuel only 20 to 25 percent of weight of coal for the same power in a steamer.

The Russian tug *Jakut*, of a towing capacity of 4,000 tons, is equipped with 320 horsepower. The engines have already worked satisfactorily for two years. The maneuvering power is better than with steam engines. The *Jakut* and a steam ice-breaker went to the assistance of a ship and towed her out of the ice. On this occasion the fuel consumption of the *Jakut* was 4.3 tons, as compared with 32 tons by the steamer.

A Diesel boat is used as a tug on the Volga. The boat has a side wheel, and it ought to be mentioned that the Diesel engine is equally well suited for this type of propulsion as the screw propeller system.

The sailing vessel *San Antonio*, which is sailing between the Baltic and the Mediterranean, was the first sailing boat to be equipped with a Diesel motor for auxiliary power. The boat has proved so satisfactory that since then the auxiliary motor sailer is now being developed on a very large scale.

The motor sailer *Quevilly* is of about 6,500 tons displacement, with 600 to 700 horsepower on two propellers. The propellers can be uncoupled when using sails only; their resistance when running light causes a loss of speed of one-half knot. This is the first ship with Diesel engines to cross the Atlantic. After the very good record of this ship, the same owners are now building another motor sailer.

The largest sailing vessel in the world is *La France*, a five-master of 10,730 tons displacement. Length, 430 feet. Sail area, 69,966 square feet. Auxiliary motor power, 1,800 to 2,000 horsepower in two Diesel engines. Will run between France and New Caledonia for the Caledonian ore trade. Was launched on the 16th of November, 1911.

The old North Polar ship *Fram* is fitted with Diesel engines. Gain through replacing the steam engines by Diesel engines: in engine space, 45 percent; weight of engine, 60 percent; weight of fuel, 80 percent; space for fuel, 85 percent. Several years' supply of fuel can be stored. Of 380 tons cargo capacity, 100 tons were previously required for the coal storage. The *Fram* sailed for six months from Christiania to the South Polar regions without touching land and without reporting. During the voyage in the Antarctic the engine worked for 2,800 hours without giving any trouble. On March 13, 1912, Capt. Amundsen, on his return from the South Pole, wired these few words: "Diesel engine excellent."

Diesel engines are installed in the Russian oil tank vessel *Dielo*, 5,700 tons displacement, 1,000 to 1,200 horsepower. This vessel made several stormy voyages on the Caspian Sea in the year 1911. It illustrates very clearly the special features of the Diesel ship; the entirely clear deck from one end to the other, no funnels, and only two small exhaust pipes on the stern, with invisible exhaust; engines on the rear end of the ship with the ship body free for cargo.

There are now a large number of oil tank vessels under course of construction in Europe; the largest one is being built by Krupp in Germany for the German Standard Oil Company; it will be 525 feet long, and will have a carrying capacity of 15,000 tons of oil.

The latest passenger and freight boat of Nobel Bros. on the Volga is the *Borodino*, equipped with two Diesel engines of 1,200 horsepower each. This boat was launched and made her trials towards the end of 1911. There are six of these boats in commission, and a ship of the same kind is being built at this time at Cockerills, in Belgium, for use on the Congo river, on order of the King of Belgium. This will be the first steel ship on colonial rivers.

To-day the navies of the world have adopted Diesel engines almost exclusively as the motive power for submarines. The submersible boat *Hvalon*, of the Swedish navy, was constructed by the F. I. A. T. Co., Italy. She is quite a modern boat, of 125 tons displacement. She left Spezia on July 30, 1911, and arrived at Cartagena, Spain, August 2, 1911, having covered the distance of 700 nautical miles without stopping. She then went to Portsmouth, thence to Kiel and Stockholm. A complete voyage of 4,000 miles was accomplished without escort and without mishap. She met with very rough weather, but behaved very satisfactorily and won high praise from her commander, Captain Magnussen. The ship is propelled by three sets of Diesel engines.

The Russian gunboat *Schtorm* is also fitted with Diesel engines. This boat, as well as two of her sister-ships, is stationed on the River Amur, in Asiatic Russia. The Russian gunboat *Kars* and her sister-ship *Ardagon*, stationed in the Caspian Sea, both have Diesel engines developing 1,000 horsepower on two propellers. The engines are of the two-cylinder, four-stroke type. Tests made in 1911 show a consumption of 333 pounds, with oil, against 1,250 to 1,390 pounds with coal.

A comparison has been made between two torpedo-boat destroyers with Diesel engines and with steam engines. In the Diesel ship the deck is perfectly free, permitting a much stronger gun equipment. The radius of action of the Diesel ship is six and a half times the radius of a steam ship. The space for the engines is one-half, which increases considerably the space for the accommodation of officers and the crew. It is of particular importance that in the Diesel ship the engines are entirely placed under the armored deck, while in the steam ship the steam engines and boilers reach up nearly to the upper deck, and the deck is surmounted by smoke-stacks. Such a Diesel engined destroyer is now being built in England. A similar comparison has also been made by English naval engineers for battleships. It is even more pronounced here than in the above comparison that the Diesel engines are entirely under the water line, which makes the ship invulnerable from the enemy, as far as her engines are concerned, and the fighting power of the ship is greatly increased.

Two sister-ships, the *Rapp* and *Snapp*, are small merchant vessels cruising in Swedish waters, of a cargo capacity of 300 tons and equipped with 120 horsepower. The engines run for long periods at 55 to 60 revolutions, although the normal speed is 300 revolutions. Since 1908 the vessels have made numerous voyages between Sweden, Finland, Germany, Holland, England, Iceland and Norway. On a voyage from the east to the west coast of Sweden, through the canal, 75 locks had to be passed, through which the maneuvering power seemed to be very satisfactory.

The first Diesel-engined seagoing vessel was the *Toiler*, cargo capacity about 3,000 tons; 360 horsepower. The steering is controlled by compressed air. The cabins are warmed by hot water, heated by the exhaust from the engines. First voyage from the Tyne to Calais with a cargo of coal was made in the summer of 1911 in very bad weather. Oil consumption, 1.65 to 1.75 tons in twenty-four hours. A steamer of the same size consumes 8 to 9 tons of coal per day; saving in cost of fuel, as compared with steamer, 50 percent. Gain in cargo capacity, 60 tons. Voyage to North America in September, 1911. Fuel consumption, 2 tons per day. Saving in cost of fuel, as compared with steam plant, $11 (2/5/10); saving in labor, $5 (1/0/10) per day. Maneuvering power proved to be very satisfactory.

The *Romagna*, of 1,000 tons displacement, 800 horsepower, was put in commission in 1910 and made regular voyages be-

tween Ravenna-Trieste-Fiume during the summer of 1911. In consequence of the faulty loading of the cargo, the vessel sank in a terrible sirocco in November, 1911.

A Diesel-engined Hamburg-American liner of 6,500 tons is under construction at the yards of the Aktien-Gesellschaft Weser, of Bremen. She will have two Diesel engines of 2,000 indicated horsepower each, and will be delivered to her owners about the middle of this year.

It is a peculiar coincidence that one hundred years separate two such events as the introduction of the marine steam engine on the River Clyde and the launching at Glasgow of the first Diesel liner built in the United Kingdom. The latter is the freight and passenger ship *Jutlandia*, which is now being completed by Messrs. Barclay, Curle & Co., and will run between Europe and Siam. The ship is of 5,000 gross tons, and will have engines of 3,000 horsepower. The fuel is carried in the vessel's double bottom. The accommodations for her passengers will be excellent; she will have magnificent staterooms, each with its own bathroom. There is a large dining saloon, smoking and music rooms. This luxurious accommodation is due to gain in space from the Diesel engine. This ship has no dangerous steam mains running everywhere, the dreaded and dirty operation of coaling is absent, and while the passengers enjoy the absence of heat from the boilers and smoke from the funnels, the owner will remember that the firemen's quarters, the boiler and bunker space, and the room occupied by numerous ventilation shafts and the funnel up-takes, may be utilized for carrying more passengers and freight, this gain in the *Jutlandia* being more than 20 percent. The exhaust from the engines will be carried up the hollow steel mizzenmast, so that no fumes reach the passengers. In place of twenty-five engineers and stokers in a similar steam-driven vessel, only eight engineers will be required to operate the new Diesel vessel.

This ship is practically a sister-ship of the *Selandia*, built by Burmeister & Wain, Copenhagen, which has been thoroughly described in previous issues of International Marine Engineering. The *Selandia* has now made her first trip to Bangkok, and it has been very successful. The cargo is 1,000 tons more than in a steamship of the same size. The owners anticipate a saving per annum in the fuel bill of $25,000 (£5,120), and a gain in the yearly freight receipts of about $15,000 (£3,080). The East Asiatic Co., owners of the *Selandia*, have just placed orders for eleven Diesel ocean liners of the same type and of tonnage ranging from 6,000 to 10,000 tons.

Floating Dock for the British Admiralty

An immense floating dock for the British Admiralty has been under construction this year at the Wallsend shipyard of Swan, Hunter & Wigham Richardson, Ltd. Some idea may be gained of its size when it is known that the ground area it covers is no less than two and a quarter acres, while the total height of the side walls is 66 feet. This is one of three docks that Swan, Hunter & Wigham Richardson, Ltd., are constructing at present for the British Admiralty, for whom they also built a battleship dock several years ago. This last named was designed for accommodating vessels displacing 17,000 tons, and is stationed at Bermuda. The latest dock has nearly twice that lifting capacity, namely, 32,000 tons. In addition to the docks built by Swan, Hunter & Wigham Richardson, Ltd., for the British Admiralty others have been constructed at the Wallsend shipyard for the governments of Natal, Southern Nigeria, Spain and Japan, and also a score for British and foreign clients all over the world. The way in which these immense structures can be towed to distant parts is most remarkable. The British Admiralty dock for Bermuda was towed nearly 4,000 miles to its destination. The floating dock for the Natal Government was towed over 8,000 miles to Durban, and a 7,000-ton dock was safely delivered a year or two ago at Callao, the port of Lima, in Peru, the distance from the Wallsend shipyard being about 11,000 miles. Other docks built by Swan, Hunter & Wigham Richardson, Ltd., have been towed to various European ports, and also to more distant one, such as Para (in Brazil), Port of Spain (in the island of Trinidad), Egypt, and the West Coast of Africa.

The dock that has just been launched is double sided, and in designing it the builders have been closely associated with Messrs. Clark & Standfield, of Westminster. At the bow end of the dock there is a pair of pivoted flying gangways, to give access from one wall of the dock to the other. In the walls of the dock is living accommodation for a number of officers and men. A complete telephone system is also installed to give communication between the engine and boiler rooms and different parts of the dock. There are eight steam boilers, which have been constructed at the Neptune Engine Works of the builders. The pumps have been supplied by Messrs. Gwynnes, Ltd. There is also a very complete outfit of steam and hand capstans placed on the walls of the dock to warp vessels into position. The dock is lighted by electricity throughout, and on the walls are two electric traveling cranes. In order to facilitate rapid repairs a commodious workshop is provided in one of the walls with an equipment of machine tools and all necessary plant and appliances. Preservative bituminous enamel in solution, made by W. Briggs & Sons, Ltd., of Dundee, has been applied to the dock externally and internally.

A River Plate Steamer

El Uruguayo is the name of a twin-screw steamer built by Messrs Alexander Stephen & Sons, Linthouse, Glasgow, for the new fortnightly service which Furness, Withy & Co., Ltd., are establishing between Liverpool and the River Plate. This service is to alternate with that of the Royal Mail Steam Packet Company.

The steamer is the first vessel to be constructed for the new service, and she is the largest vessel ever entirely designed for the carriage of chilled and frozen meat. Her insulated capacity is over 400,000 cubic feet.

This vessel is 456 feet in length over all by 59 feet beam by 38 feet molded depth. Of the shelter deck type, she has four complete decks fore and aft, with long bridge and boat deck amidships and a forecastle forward. The hull was constructed in details specially arranged by the builders with the British Corporation for the work of insulation and in accordance with the requirements of the meat-carrying trade. The shell, underside of decks, bulkheads and tank tops are insulated with granulated cork, and all the decks in the refrigerated spaces are laid with Litosilo.

For effective cargo working the hatches are trunked and insulated through the four decks, so that any part of the ship can be loaded or discharged without affecting the refrigeration of the remaining portions. The hatch trunks are arranged for the reception of carcasses.

All the cargo gear, derricks and winches have been arranged so that three gangs of men can work simultaneously at each of the large hatches. This will permit of the rapid discharge of an enormous cargo of meat.

The work of insulation is carried out by the builders and the refrigeratiing machinery is installed by Messrs. J. & E. Hall, Dartford. Each chamber is cooled by brine circulation to a temperature suitable for chilled or frozen meat. The machinery is controlled entirely from the refrigerating engine room, and the brine grids are specially designed for chilling as well as freezing meat. The refrigeration machinery is in duplicate throughout.

The propelling machinery constructed by the builders consists of twin-screw, triple-expansion engines with cylinders 25 inches, 41½ inches and 70 inches diameter by 48 inches stroke. Steam is supplied from six large boilers working under Howden's system of forced draft at a pressure of 200 pounds. There is a large outfit of auxiliary machinery.

On the bridge deck accommodation is provided for officers and engineers. There are also staterooms, saloon, smoke room, etc., for a limited number of first class passengers. And inside the bridge and poop are comfortable quarters for about 400 emigrants.

The work of construction, both of hull and machinery, has been under the supervision of Messrs. William Esplen & Son, Liverpool.

Launch of the Latest British Battleships and Battle Cruisers

The launch by Scotts' Shipbuilding & Engineering Company, Greenock, of the latest super-dreadnought battlehip for the British navy, together with the launch at Jarrow of the battle cruiser *Queen Mary,* makes a remarkable record in the story of any fleet. The addition, on consecutive days, of two vessels, each the largest and most powerful of its class, and each more powerful than any ships of the same type yet built for any other navy, marks a very definite stage in British naval progress. The battleship *Ajax* was laid down at Greenock on Feb. 27, 1911, and will be commissioned early next year. Scotts' Company build not only the hull but also the turbines and boilers and all the other necessary machinery.

From the time when the vessel began to move on the ways until she was fully water-borne seventy seconds elapsed. The launching weight of the hull was rather more than 9,000 tons, and the breadth of the launching ways was 6 feet. The vessel was released by the old method of dogshores and falling weights, the mechanism working perfectly.

The *Ajax* is a battleship of the *Dreadnought* type, with better armor protection than the original ship, 13.5-inch guns instead of 12-inch guns in her main armament, and 4-inch guns instead of 12-pounders in her anti-torpedo boat armament. The *Dreadnought's* greatest broadside fire is 6,800 pounds, from eight 12-inch 45-caliber guns; that of the *Ajax* will be 12,500 pounds, from ten 13.5-inch guns. The guns of the *Ajax* are installed in pairs in turrets on the middle line of the ship. The *Colossus* is also able to use all of her ten 12-inch 50-caliber guns on either beam, two of her five turrets being placed *en echelon* on the wings. Her greatest broadside fire is, roughly, 8,500 pounds, as compared with 6,800 pounds for the *Dreadnought* and 12,500 pounds for the *Ajax*. The *Dreadnought* has twenty-seven 12-pounders in her anti-torpedo boat armament. The corresponding provision in the *Ajax* is, as in the *Colossus,* sixteen 4-inch guns. They are single-tier armored batteries, and are disposed so as to give the best possible protection against torpedo attack.

The main armor protection is also better. The side armor, greatest thickness 12 inches, extends for nearly two-thirds of the vessel's length. The two lower strakes are of 12 inches, above that is one of 9 inches and above that one of 18 inches. Forward and aft of the heavily protected part of the ship armor tapering from a thickness of 6 inches extends to the stem and the stern.

All this increase of offensive and defensive qualities finds expression in larger dimensions. Between perpendiculars the *Ajax* is 555 feet long. Her beam is 89 feet 6 inches, and her draft 27 feet 6 inches. The displacement is slightly more than 23,000 tons. In order to drive the bigger ship at the same speed as that of the other *Dreadnought* the propelling machinery, which consists of Parsons turbines arranged for four screws, will develop about 31,000 shaft-horsepower. All the battleships of the *Dreadnought* type have designed speeds of 21 knots.

The launch of His Majesty's battle cruiser *Queen Mary* was from the yard of Palmer's Shipbuilding & Iron Company, Ltd., Jarrow.

The *Queen Mary* is the second largest vessel of any description ever launched on the Tyne, the largest being the *Mauretania,* launched at Wallsend. The *Queen Mary* is some 90 feet less than the *Mauretania* in length.

The *Queen Mary* is a dreadnought cruiser of the *Lion* class and of the *Invincible* type. Compared with the *Ajax* she has 105 feet more length between perpendiculars, about the same beam and 6 inches more draft. The displacement will be about 27,000 tons. The *Queen Mary* is practically a sister ship of the *Lion* and the *Princess Royal.* She is a similar ship to the *Tiger,* although there is a difference in beam between the *Princess Royal* and the *Tiger* of, roughly, 2 feet.

Comparing the *Queen Mary* with the *Invincible* she is between perpendiculars 130 feet longer than that vessel. Her beam is at least 10 feet greater, and she draws nearly 3 feet more water. Both ships can use all of the eight guns in their main armaments on either broadside, although the dispositions of the turrets are different. In the *Invincible* two turrets, each containing two guns, are placed *en echelon* on the wings. In the *Queen Mary* all the eight guns are in four turrets on the middle line. The *Invincible's* are 12-inch 45-caliber guns, while the *Queen Mary's* are 13.5-inch 50-caliber guns, so that in the case of the earlier ship the full broadside fire expressed in weight of projectile is 6,800 pounds, and in the case of the later ship 10,000 pounds.

The anti-torpedo guns in all the ships of the type up to the *Queen Mary* are of 4-inch caliber. Those in the later ships are better weapons and capable of much more effective use. In the *Queen Mary* the anti-torpedo armament is better disposed and better protected than it is in any ship prior to the *Lion.* The guns are in armor casemates, and not in unprotected batteries. The thickest side armor is on the *Queen Mary,* not much, if any, greater than that of the *Princess Royal,* which is 9 inches. The thickest side armor on the *Invincible* is 7 inches.

The designed speed of the *Queen Mary* is 28 knots, and to obtain this Parsons turbines are arranged for four screws, and estimated to give about 75,000 shaft-horsepower. They are provided by Messrs. John Brown & Company, Ltd., Clydebank. The designed speed of the *Invincible* was 25 knots, and the shaft-horsepower necessary to obtain it was estimated at 41,000. Actually the speed on trial was 28 knots with 44,800 shaft-horsepower.

Both the *Ajax* and the *Queen Mary* are much better ships than their predecessors. The primary duty of battleships was originally to control maritime communications, and of cruisers to exercise control under cover of the battleships. If a cruiser line exercising control was attacked by isolated heavier ships it had to concentrate or run, and in either case the control was broken. In order to repair this deficiency cruiser lines were given resisting power. That was the beginning of the development whose latest phase is the *Queen Mary.* Cruiser screens to battle fleets had to be correspondingly augmented. Then came the torpedo, until now armored cruisers are used not only to scout and to strengthen cruiser screens but in squadrons have been given definite tactical functions in battle. They screen, scout, control and fight in lines of battle. There is now no broad, dividing line between types of warships, judging the matter by the work they can do.

Analysis of the Trial Trips of the Battleship Florida

BY SIDNEY G. KOON, M. M. E.

Analyses of the results of the standardization and the official trials of this new dreadnought battleship give some interesting results. In the accompanying two diagrams are given fourteen curves derived from these analyses—the eight in Fig. 1 being based on the speed, and the six in Fig. 2 on the horsepower, as shown.

The "parent" curve, so to speak, is that for speed and shaft-horsepower, in Fig. 1. This is derived from a combination of

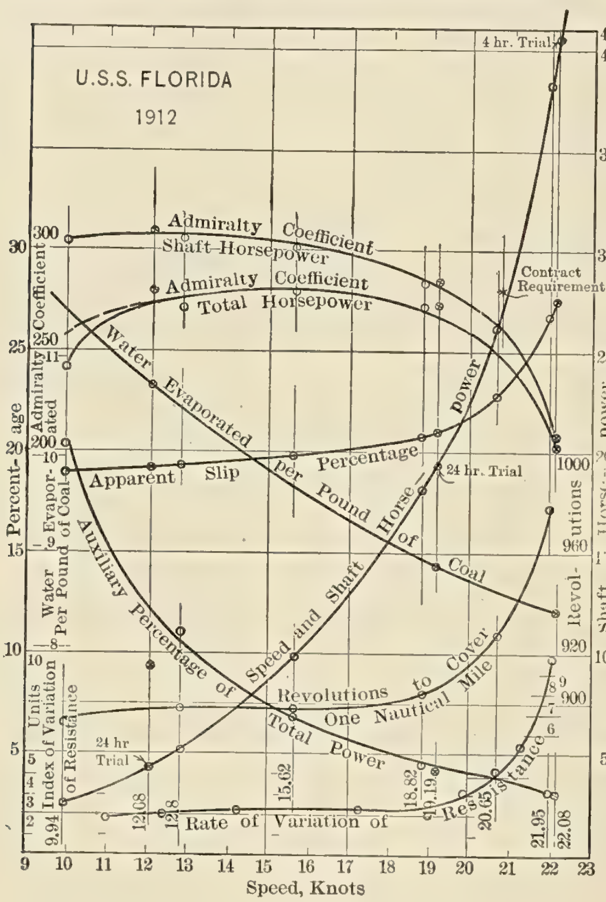


FIG. 1

the standardization trials and the three official trials. To illustrate how this curve was obtained from the separate runs on the standardization trials, with and against the tide, Table I. is given; while Table II. exhibits the final results of putting all the sections of the standardization trials through this same process. Each such section or group comprises naturally those runs made at approximately the same number of revolutions per minute.

From the results in Table I. and Table II. is readily obtained the information relating to the speed the "revolutions to cover 1 nautical mile." This is seen to be practically constant up to about 18 knots speed, indicating that the slip over this

TABLE I.

Run Number	7	8	9	A Mean 7 and 8.	B Mean 8 and 9.	Final Mean A and B.
Revolutions per minute	233.8	230.1	236.1	232.	233.1	232.5
Revolutions per mile	824.	959.	850.	891.5	904.5	898.
Speed, knots	17.03	14.39	16.67	15.71	15.53	15.62
Shaft horsepower	9742.	9872.	10108.	9807.	9990.	9899.
Auxiliary horsepower	755.	746.	723.	750.	735.	742.
Total horsepower	10497.	10618.	10831.	10557.	10725.	10641.

range is nearly constant—a fact brought out later. After reaching 18 knots the curve mounts abruptly. Reference to the apparent slip curve shows, naturally, a similar characteristic.

The curves for Admiralty coefficient are figured from the well-known formula

$$K = \frac{D^{2/3}\ V^3}{H},$$

where K is the coefficient sought, D is the displacement of the ship in tons, V is the speed in knots and H is the horsepower. Two curves are shown, in one of which H signifies the shaft-horsepower only, while in the other H is the total horsepower of the propelling machinery and all its auxiliaries. The former represents the theoretical hull efficiency, on the probably untenable assumption that the hull coefficient of propulsion is a constant. The latter represents the practical efficiency of sending the vessel through the water at varying rates of speed.

The curve showing percentage relation between horsepower of auxiliaries and total combined horsepower of propelling engines and their auxiliaries is taken direct from the figures given for the trials of the ship. It varies from more than 20 percent at 10 knots to a trifle over 3 percent at 22 knots. It will be shown later that the 20 percent auxiliary power at 10 knots absorbs more steam (and hence coal) than does the 80 percent propelling engine power at that speed. It will be noted that all the figures and curves given are taken from results of both standardization and official trials.

The apparent slip percentage curve was obtained by relating the speed at each point to the product of the propeller pitch (8½ feet) and the revolutions per minute. For instance, at 15.62 knots the speed of the ship is 1,583 feet per minute.

TABLE II.

Trial or run	4–5–6.	24-Hour.	1–2–3.	7–8–9.	10–11–12.	24-Hour.	20–21–22.	15 to 19.	4-Hour.
R. P. M.	146.3	178.5	189.2	232.5	283.2	289.5	319.	358.6	363.9
Revolutions, 1 mile	897.5	......	899.	898.	904.	......	927.1	980.5	......
Speed	9.94	12.08	12.8	15.62	18.82	19.19	20.65	21.95	22.08
Shaft horsepower	2516.	4433.	5325.	9899.	18284.	19359.	25979.	38225.	40511.
Auxiliary horsepower	640.	464.	665.	742.	866.	863.	1119.	1240.	1299.
Total horsepower	3156.	4897.	5990.	10641.	19150.	20222.	27098.	39465.	41810.
V^3	982.	1763.	2097.	3811.	6666.	7067.	8806.	10576.	10765.
K_a	243.	281.2	273.4	279.7	271.8	272.9	253.8	209.3	201.1
K_b	304.8	310.6	307.6	300.7	284.8	285.1	264.7	216.1	207.5
Auxiliary horsepower, percent of total	20.27	9.48	11.1	6.97	4.52	4.27	4.13	3.14	3.11

a. Based on total horsepower.
b. Based on shaft horsepower only. $D^{2/3} = 781$.

The revolutions (232.5 per minute) multiplied by 8½ gives 1,976 feet per minute advance of the screw. The difference, or slip, is thus 393 feet per minute, which represents 19.9 percent of the propeller's own speed.

The ratio of variation of resistance is a very important consideration. The curve, which shows that the resistance varied about as the second power (the square) of the speed up to 19 knots, shows a sharp advance after that point is reached, until, at 22 knots, the index is nearly 10. The points on this curve were obtained on the assumption that the resistance index between any given speed reading and the next $V = 12.08$; $H_1 = 2516$; $H = 4433$. Then $\frac{H}{H_1} = 1.762$; $\frac{V}{V_1} = 1.215$; $\log \frac{H}{H_1} = 0.24601$; $\log \frac{V}{V_1} = 0.08458$. From this $x + 1 = 0.24601 \div 0.08458 = 2.909$, and $x = 1.909$. Thus the power varies as the 2.909 index of the speed, and the resistance as the 1.909 index of the speed as plotted on the curve. The other points on the curve were all obtained in the same way, and each was plotted on the mean between the two

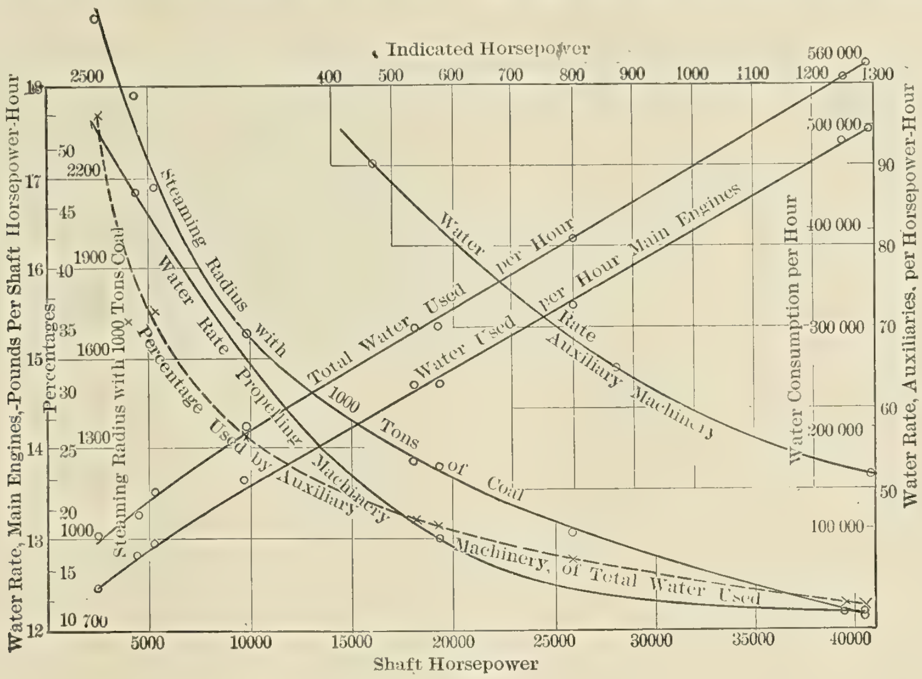


FIG. 2

adjacent one was practically constant. This also assumes a constant propulsive coefficient.

Thus, if we refer to the formula $R = A\,V^x$, where A is a constant, V is the speed, R is the resistance at that speed, and x is the rate of variation of R, we are assuming x constant for relatively slight variations of V. Now $H = B\,V\,R$, where B is another constant. Then $H = B\,V\,A\,V^x = A\,B\,V^{(x+1)}$. Reduced to logarithms this last becomes $\log H = \log A\,B + (x + 1) \log V$; also $\log H_1 = \log A\,B + (x + 1) \log V_1$. Subtracting $\log H - \log H_1 = (x + 1)(\log V - \log V_1)$, whence $\log \frac{H}{H_1} = (x + 1) \log \frac{V}{V_1}$.

Taking the first step in our order of speeds, $V_1 = 9.94$; speeds compared. The result must be considered as approximate only, but the approximation may be assumed to be substantially correct.

Turning next to Fig. 2 we have the water rate of the propelling machinery, the curve being drawn from three spots—those representing 12.08, 19.19 and 22.08 knots speed. Similarly, the curve for water rate of the auxiliary machinery is based on three spots, representing these same three speeds.

Using these curves as bases and the observed horsepowers, figures may be obtained for the water consumption per hour of both main and auxiliary machinery. These give the two curves running "*S. W.* to *N. E.*" across the diagram. The lower curve gives results for the main engines only, the upper for main and auxiliary engines together.

TABLE III.

Shaft Horse-power.	Apparent Slip, Percent.	Index of Variation of Horse-power.	Index of Variation of Re-sistance.	Water Rate Propel-ling.	Water Rate Aux-iliaries.	Total Water Hourly Consump-tion, Pro-pelling.	Total Water Hourly Consump-tion, Aux-iliaries.	Total Water Hourly Con-sump-tion, All.	Total Water Hourly Con-sump-tion, Aux-iliary, Percent.	Water Con-sump-tion per Nautical Mile.	Water Evapo-rated per Pound of Coal.	Coal Burned per Nautical Mile.	Steaming Radius with 1,000 Tons of Coal, Miles.	Steaming Radius with 1,000 Tons of Coal, Hours.
2,516	18.99	....	....	17.58	....	44,030	48,832	92,862	52.59	9,341	11.4	819	2,734	275.
4,433 a	19.32	2.909	1.909	16.815	90.18	74,543	41,843	116,386	35.96	9,634	10.658	904	2,478	205.
5,325	19.35	3.172	2.172	16.43	76.3	87,490	49,875	137,365	36.31	10,732	10.425	1,029	2,176	170.
9,899	19.9	3.113	2.113	15.	75.	148,485	52,385	200,870	26.08	12,860	9.65	1,333	1,681	107.6
18,284	20.76	3.29	2.29	13.17	70.6	242,820	56,578	299,398	18.9	15,908	8.93	1,781	1,257	66.8
19,359 a	20.98	3.	2.	13.	65.33	251,669	56,382	308,051	18.3	16,053	8.872	1,809	1,238	64.5
25,979	22.8	4.011	3.011	12.45	56.9	323,439	63,671	387,110	16.45	18,745	8.63	2.172	1,031	49.9
38,225	27.	6.322	5.322	12.2	53.5	466,345	66,340	532,685	12.41	24,959	8.45	2,954	758	34.5
40,511 b	27.67	9.735	8.735	12.18	51.85	493,428	67,352	560,780	12.01	25,399	8.423	3,015	743	33.6

a. Twenty-four-hour official trials.
b. Four-hour trial. Others, standardization.

The percentage of water consumed by the auxiliary machinery to the total water consumed by all machinery, follows readily from the figures of the last paragraph. This, again, is represented by a curve.

Taking the curves as a whole, it will be noted that the most efficient propulsion is at about 16 knots. In this connection it is of interest to note that the total horsepower required by this 21,200-ton (trial displacement) ship at 15.62 knots was 10,641, or half horsepower per ton. The 10,225-ton *Indiana,* in 1896, for 15.55 knots required 9,607 indicated horsepower, or 0.94 horsepower per ton. Had the *Florida's* propulsion been only equally effective, this speed would have called for 16,145 horsepower, which would actually give her now a speed of over 18 knots. This power is more than 50 percent in excess of what the *Florida* actually required for the *Indiana's* speed.

This sort of result is splendid; so, from the point of view of the design of the ship and her powering, is the fact that the designed speed was obtained on almost exactly the 28,000 designed horsepower. But the obtaining of over 41,000 horsepower out of machinery designed for 28,000, while gratifying as showing the overload possibilities of her propelling apparatus, is not evidence of the best engineering design.

It is also evident that the ship was designed for 20.75 knots, and *no more;* for the extra 1 1/3 knots achieved cost an extra 14,000 horsepower, or an excess of 50 percent more power, in fact, than was absorbed by the first 17 knots. This is two and one-half times what it would have cost in a ship properly designed for the higher speed.

Those derived figures which are not found in the published records of the *Florida* are given in Table III.

Fast Steam Yacht Winchester Launched

The new turbine express steam yacht *Winchester* was successfully launched at the yard of the builder, Messrs. Yarrow & Co., Scotstoun, on May 15, and will be rapidly pushed to completion, so that she may be delivered to her owner, Mr. P. W. Rouss, at the earliest possible date. The yacht was designed by Messrs. Cox & Stevens, of New York, and the contract was awarded to Yarrow & Co. by reason of the very satisfactory results obtained in the previous *Winchester*, the construction of which Messrs. Cox & Stevens had also entrusted to the same builders.

The new *Winchester* is an entire departure from the conventional type of express steam yachts, and her appearance in these waters is looked forward to with much interest by all who follow progress in matters of this character. She is 205 feet in length, her beam is 18 feet 6 inches, and her contract speed, which the architects believe will be exceeded, is 32 knots. The propelling machinery consists of a twin-screw Parsons turbine installation, supplied with steam by water-tube boilers of the Yarrow type, oil-fired. In appearance, the hull is not unusual, and although the novelty of the design may to some appear so unusual as to lead to adverse criticism, anyone having actual knowledge of the results desired and a sense of the fitness of things nautical will at once appreciate its merits and the actual beauty of the lines.

The vessel has a flush deck throughout, having practically a straight sheer, and for a distance of about one-quarter the length from the stem the freeboard is raised to form an upper forecastle, as is done in the modern torpedo-boat destroyers. The deck dining-room, which is unusually large, is placed directly aft of this raised portion, and the forecastle deck is carried aft over the dining-room, forming one continuous level. By this means of construction the vessel has sufficient freeboard forward to enable her to be driven comfortably at high speeds, even in rough weather, and all possibility of the windows in the dining-room being broken by water coming on board is removed.

The awning runs in one continuous line from the break in the deck forward to the after end of the vessel, and there is a comfortable after-deck house to provide deck shelter in stormy weather. The *Winchester* has two stacks, oval in shape and of large size, one signal mast, and a complete equipment of launches and boats. She is to be painted black, and, with her striking and clean lines, will unquestionably look every inch what she is meant to be—namely, an express vessel of extreme speed and capable of maintaining this speed under adverse conditions with the greatest possible comfort and safety to those on board.

TURBINE EXPRESS YACHT WINCHESTER

While the propelling machinery occupies a very considerable proportion of the interior, the owner has unusually comfortable accommodation for himself and guests aft, so that he can make extended cruises in comfort; and the fuel supply being large, the customary annoyance of frequent coaling, which is essential in all coal-burning vessels of this type, will be obviated. The raised forecastle is taken advantage of to form most comfortable quarters for the officers, below which is the regular forecastle with berthing and messing spaces for the crew.

Mr. Rouss is to be congratulated upon his perseverance in the development of the express steam yacht, the present *Winchester* being the third of that name built for him within the past five years. The first *Winchester,* now called the *Adroit,* was sold by Messrs. Cox & Stevens to Mr. Alfred Vanderbilt, and immediately on her sale Mr. Rouss entrusted this firm of architects with the placing of the order for the second *Winchester,* which was the first oil-burning turbine express steam yacht ever built. Last fall Mr. Rouss, having had such a satisfactory experience with the second *Winchester,* and being desirous of owning a larger and faster vessel of the same type, commissioned Messrs. Cox & Stevens to sell the second *Winchester* and to design and have built a new vessel, the result of which is the new *Winchester.*

Trial Trip of a Steel Screw Steamer

On March 4 the steamship *Atlantic City,* built by Messrs. Ropner & Sons, Ltd., of Stockton-on-Tees, made her official trial trip in the Tees Bay. The steamer has been built to 100 A1 Lloyds, and is for the Bradford Steamship Company, Ltd., Cardiff (Messrs. W. R. Smith & Son, managers). She is about 392 feet long and has a deadweight carrying capacity of about 7,900 tons. The accommodation for captain, officers and engineers is in houses on the bridge deck, with the crew in the forecastle. The engines are of the triple-expansion type, of about 1,900 indicated horsepower, by Messrs. Blair & Company, Ltd., of Stockton-on-Tees.

The vessel has been built under the superintendence of Capt. J. H. Smith, and on trial attained a speed of over 11 knots. She is particularly well equipped with cargo-handling gear of the most improved type for the loading and discharge of heavy cargoes.

Economy Due to Superheated Steam in Marine Practice

BY WALTER M. McFARLAND *

The theoretical advantages of the use of superheated steam were evident at an early date, as indeed would be inevitable when the principle of the Carnot heat cycle was understood. In the early days, when materials were not nearly so good as at present, and steam pressures were accordingly much lower, the benefit of getting the economy due to a very much higher initial temperature with no increase of pressure was, of course, obvious. Accordingly, very many experiments were made and a number of plants were installed using superheated steam, often with special superheating boilers. On the whole, these early installations were not practical successes, on account of the rapid corrosion of the superheaters, although the heat economy was obtained. In those days workmanship was not so good as now, and the causes of corrosion were not only not properly understood but there was dense ignorance concerning them, so that the measures taken to prevent corrosion really increased it. Obviously, there was no commercial economy in a system where the cost of repairs far exceeded the saving due to increased thermal economy.

In more recent years, since corrosion has been better understood and the means for preventing it are fairly well known, the attractiveness of the benefit to be derived from superheating has led to its reintroduction, and this article is intended to be a brief discussion, with some illustrative examples, of the economy which comes from the use of superheat.

In land installations, where poppet valves can be used, so that the question of valve friction does not come up, superheat may be used to almost any degree that is desired, and there are a great many examples of such engines on the Continent of Europe which are working with a remarkable degree of economy, in some cases very closely approaching 1 pound of coal per horsepower-hour.

With the steam turbine, where there are no rubbing surfaces, the benefit to be derived from superheat was at once apparent, and, generally speaking, it may be said that all the large power houses and central stations which use steam turbines also use superheat. In these cases there is not only the thermal economy due to superheat, but it has been found that the dry steam has much less erosive action on the blades of the turbines than steam which is moist. An excellent article by Capt. C. A. Carr, U. S. N., published in the *Journal* of the American Society of Naval Engineers for February, 1911, gives a great deal of information with respect to these land plants, and will repay very careful study. Speaking generally, it is considered that with steam turbines of modern design and carrying from 175 to 200 pounds of steam pressure, there is a saving in steam consumption of about 1 percent for each 10 degrees of superheat.

About ten years ago, Capt. Augustus B. Wolvin, then the manager of a number of steamboat lines on the Great Lakes, and who has been one of the poineers in the adoption of improvements in marine machinery tending to economy, installed Babcock & Wilcox boilers and superheaters in one of the vessels under his control, and followed this by similar installations on several other vessels. One of these, the *James C. Wallace,* was subjected to a test by a board of naval engineer officers, and showed a saving in coal of about 9 percent, with an average superheat at the engine of about 85 degrees. The Bureau of Steam Engineering took up this subject, and in 1904 ordered Babcock & Wilcox boilers and superheaters to replace the old cylindrical boilers on the *Indiana.* This was followed by installations of similar boilers and superheaters on the *Massachusetts* and the *New York* (now *Saratoga*) in the way of replacements, and on the *Michigan, South Carolina, Prometheus, Vestal, Delaware, North Dakota, Texas* and *New York* (new), new vessels. In 1905 boilers and superheaters from the same makers were ordered for the steamship *Creole,* with respect to whose performance some interesting data will be given later on. The Pennsylvania Railroad, in its marine service, has always shown a desire to get the safest and most efficient machinery, and in 1909 ordered from this concern boilers and superheaters for three of their large tugs, the *Johnstown, Wilmington* and *Harrisburg,* which have given great satisfaction and economy in service. The steam yacht *Idalia* also has a boiler and superheater supplied by this same firm.

* With the Babcock & Wilcox Company, New York.

It will thus be seen that superheat is in use on a large number of vessels, and undoubtedly a great deal of experience has been accumulated, but, unfortunately, not very much has been published.

TABLE I.—ECONOMY DUE TO SUPERHEATED STEAM—MERCHANT VESSELS.

Name of vessel	Creole.	Momus and Antilles.
Date of tests	1910	1908–9–10
Length, feet	407	410
Beam, feet	53	53
Draft, feet	26.7	25.6
Tonnage, gross	6,754	6,878
Tonnage, net	4,302	4,326
Cylinders, diameter and stroke	(2) 27¾, 46½, 79, 42	(1) 34, 57, 104, 63
I. H. P.	7,000	7,500
Boiler pressure, pounds	210	210
Kind of boilers	Babcock & Wilcox, with superheaters.	Scotch, no superheater.
Ratio of superheating to evaporating surface, percent	1 to 15.5	....
*Av. coal per trip for five round trips, tons	1,149	1,374
Percentage of saving by use of B. & W. boiler and superheater	†16.38	.....
Av. coal per trip for two round trips, each vessel, in October, 1910	1,206	1,461
Percentage of saving by use of B. & W. boiler and superheater	†17.45	......

*The *Creole's* trips were in summer of 1910; those of the other ships are their most economical trips in summers of 1908, '09 and '10.

†The improved economy is due partly to greater efficiency of boiler of *Creole* and partly to superheat. See text for analysis and discussion.

Table I. gives the performance of the steamship *Creole,* which is fitted with Babcock & Wilcox boilers and superheaters, as compared with the performance of her two sister ships, the *Momus* and *Antilles,* which have ordinary cylindrical boilers without superheat. As shown by the table, the hulls are practically identical. The *Creole* has twin screw engines of about 7,000 horsepower, while the *Momus* and *Antilles* have single screw engines of about 7,500 horsepower. All three ships carry about the same steam pressure—about 210 pounds. The *Creole* was originally fitted with Curtis turbines, but the speed was too low (15½ knots) to permit economical use and they were removed. It is to be noted that so far as there is any advantage in engine economy it should be with the *Momus* and *Antilles,* which have each a single engine of about the same power as the aggregate of the two engines on the *Creole,* thereby reducing the losses due to cylinder condensation. The engines are all triple expansion and of excellent design. The *Creole's* first trip with her new engines was made in the spring of 1910. Two comparisons are given, one of five round trips of the *Creole* in the summer of 1910, as compared with five round trips of each of the others, obtained by taking their best performances in the three summers of 1908, 1909 and 1910. The second comparison is between two round trips of all three vessels made in the

month of October, 1910. They run over the same route from New York to New Orleans, and, as the hulls are identical and the engines designed and built by the same firm, the only material difference is in the boilers and superheat. The table shows that the *Creole* operates with about 17 percent less fuel per round trip than her sister ships. The average superheat carried is about 60 degrees, from which a saving of about 6 percent would be expected. It is to be noted, however, that there is a distinct gain in economy due to the use of the Babcock & Wilcox boiler, as contrasted with the cylindrical or Scotch boiler.

In an article by the late Admiral George W. Melville, U. S. N., published in the *Engineering Magazine* for January, 1912, are given reports of very accurate tests of Scotch boilers and of Babcock & Wilcox boilers, made by boards of navy officers and committees of independent engineers, so that the reliability of the data is beyond question. These tests showed that, at the rate of combustion obtaining in these vessels, the Babcock & Wilcox boiler shows an efficiency of about 74 percent, as against from 62 to 67 percent (average 64.5 percent) for the Scotch boiler. Working out the saving due to this greater efficiency, it comes to 11.7 percent, and this subtracted from 17.45 percent, the total saving, leaves 5.75 percent as the saving due to superheat, which agrees quite well with the rough general rule of 1 percent saving for each 10 degrees of superheat.

Table II. gives the performance of four United States navy vessels, all of the same displacement and approximately the same power, and all fitted with Babcock & Wilcox boilers. The *Kansas* and the *New Hampshire* have no superheaters, while the *Michigan* and the *South Carolina* are fitted with superheaters. The performance of these four ships is very interesting, showing a saving, based on the average of the two ships with superheaters as contrasted with the two without, of 18.52 percent. In this connection it is interesting to note the remarks of Commander Henry C. Dinger, U. S. N., formerly editor of the *Journal of the American Society of Naval Engineers,* who wrote the account of the trial of the *South Carolina,* and who says with respect to the better performance of the ships with superheaters:

"The engines of the *Michigan* and *South Carolina* represent a decided advance in economy of steam consumption of navy reciprocating engines. The design embodies the use of (1) superheated steam; (2) large ratio of cylinders, namely, $\frac{H.P.}{L.P.} = \frac{1}{10}$, and (3) a considerable reduction of cylinder clearance. Calculations from indicator cards indicate that the steam consumption at full power was about 12.6 pounds of water per indicated horsepower. This result may be considered as being within a few percent of the actual consumption. This shows a gain of about 16 percent over previous navy practice; of this gain one-half may be assigned to the use of superheated steam, and the other half due to the reduction of clearance and better cylinder proportions."

The dimensions of cylinders of all four ships are given in the table.

In October, 1909, a test was made of the machinery of the yacht *Idalia* with superheated steam by Dr. D. S. Jacobus, and witnessed and reported by Lieut. John Halligan, Jr., U. S. N. The owner of the *Idalia* is an accomplished engineer, which insures the maintenance of the machinery in first-class condition at all times. She has a four-cylinder triple-expansion engine, the cylinder diameters being 11.5 inches, 19 inches, (2) 22.7 inches by 18 inches stroke. All the cylinders are unjacketed and have piston valves. There is one Babcock & Wilcox boiler, with 65 square feet of grate surface and 2,500 square feet of evaporating surface and 340 square feet of superheating surface. These tests are notable from the fact that the weight of the steam used was carefully determined by weighing the steam condensed in tanks on carefully standardized platform scales. The actual duration of the test in each case was about two and a half to three hours, but observations were made every fifteen minutes. The well-known reputation of Dr. Jacobus as an experimenter insures the accuracy of the results, which are given in Table III. The duration of the experiments was obviously too short to make it worth while to attempt to measure the coal. It is to be noted that the feed, air and circulating pumps, all of which are independent, discharge their exhaust steam into the main condenser, so that the figures given for steam per horsepower include the steam used by these auxiliaries, as well as by the main engine, while the horsepower is of the main engine only. This is mentioned in order that the results, which might otherwise be considered rather high, may be thoroughly understood.

We have now given such experimental data as are available of measurements of coal and water to show the economy of superheating, and, as stated above, they bear out the rough rule that there is about 1 percent in saving of fuel for each 10 degrees of superheat.

The practical effect of superheated steam is, of course, to give a greater thermal efficiency to the engine in which it is used and reduce the number of pounds of steam required per

TABLE II.—ECONOMY DUE TO SUPERHEATED STEAM. OFFICIAL TRIALS OF UNITED STATES NAVAL VESSELS.

Name of Vessel	Kansas.	New Hampshire.	Michigan.	South Carolina.
Builders	New York Shipbuilding Co.	New York Shipbuilding Co.	New York Shipbuilding Co.	Wm. Cramp & Son S. & E. B. Co.
Date of trial	Dec. 14, 1906.	Dec. 20, 1907.	June 10, 1909.	August 25, 1909.
Displacement on trial, tons	16,000	16,145	16,064	16,064
Twin screw engines, diameter and stroke of cylinders, inches	32½, 53, (2) 61; 48	32½, 53, (2) 61; 48	32, 52, (2) 72; 48	32, 52, (2) 72; 48
Kind of boilers	Babcock & Wilcox.	Babcock & Wilcox.	Babcock & Wilcox.	Babcock & Wilcox.
Evaporating surface in use, square feet	52,752	47,112	42,432	42,432
Superheating surface in use, square feet	No superheaters.	No superheaters.	5,174	5,174
Ratio superheating to evaporating surface, percent	....	....	12.2	12.2
Heating surface, total square feet	52,752	47,112	47,606	47,606
Grate surface, total square feet	1,097	1,100	1,046	1,046
Ratio evaporating to grate surface	48.0 to 1	42.81 to 1	40.6 to 1	40.6 to 1
Speed, average for trial (4 hours)	18.004	18.162	18.79	18.86
Revolutions, average per minute (4 hours)	121.32	118.75	119.46	121.28
Steam pressure at boilers, gage, pounds	278.2	246.00	297.70	285.00
Steam pressure at high-pressure steam chest, gage, pounds	250.0	222.00	246.00	241.00
Steam pressure, first receiver, absolute, pounds	106.5	93.00	77.40	96.50
Steam pressure, second receiver, absolute, pounds	38.0	32.20	8.10	35.10
Vacuum in condensers, inches of mercury	28.0	25.60	27.00	26.2
Superheat at high-pressure chest, degrees Fahrenheit	None.	None.	85.70	47.5
I. H. P. of main engines only	19,302.00	16,772.00	16,016.45	17,651.00
I. H. P. of all auxiliaries in use	455.00	495.00	500.85	706.00
I. H. P. total	19,757.00	17,267.00	16,517.30	18,357.00
Coal per hour per I. H. P. of main engines	1.779	1.785	1.51	1.395
Coal per hour per I. H. P. of main engines and all auxiliaries	1.737	1.773	1.46	1.341
Coal per hour per square foot grate surface	31.21	27.21	23.28	23.47
Air pressure in fire rooms, inches of water	0.60	0.49	0.67	0.78

TABLE III.—ECONOMY OF SUPERHEATED STEAM. TESTS ON YACHT IDALIA. SUMMARY OF TESTS.

Date, 1909.	Conditions.	Pressures.			Vacuum.	Temperatures.		R. P. M.		Revolutions per Minute, Main Engine.	I. H. P., Main Engine.	Water per Hour, Total.	Water per I. H. P.	Per-cent Saving of Steam.
		Throttle.	First Receiver.	Second Receiver.		Feed.	Hotwell.	Air Pump.	Circulating Pump.					
Oct. 11....	Saturated.......	190	68.4	9.7	25.5	201	116.0	57	196	194.3	512.3	9,397	18.3	.....
Oct. 14....	Superheat, 57°...	196	66.0	9.2	25.9	206	109.5	56	198	1 1.5	495.2	8,430	17 0	7.10
Oct. 14....	Superheat, 88°...	201	64.3	8.7	25.9	205	115.0	53	196	195.1	521.1	8,234	15.8	13.66
Oct. 12....	Superheat, 96°...	198	61.9	7.8	25.4	202	111.5	54	198	191.5	498.3	7,902	15.8	13.66
Oct. 13....	Superheat, 105°..	203	63.0	8.4	25.2	200	111.0	45	197	193.1	502.2	7,790	15.5	15.30

horsepower. The question has frequently been raised whether there is a corresponding saving in fuel. That is, will not the fact that a pound of superheated steam contains more thermal units than a pound of saturated steam require in the long run a greater expenditure of fuel per pound of steam, so that, although fewer pounds of steam are used per horsepower, it takes a greater amount of coal for a given number of pounds of water evaporated? Speaking generally, it may be asserted that with superheaters properly designed and located, and within the limit of superheat ordinarily used in marine practice—50 to 100 degrees—such tests as have been made, and such general experience as has been gained, tend to show that there is in the long run practically no increase in the fuel per pound of steam, or, in other words, there would be almost exactly the same percentage of reduction in the amount of fuel used as in the amount of steam per horsepower. It is not difficult to understand why this should be the case in a properly designed arrangement of superheaters. In all the cases cited, and which are the only ones for which data are available, the superheaters are used with Babcock & Wilcox boilers. As is well known, a system of baffling is used in these boilers which causes the hot gases to cross the tubes three times on their way from the furnace to the up-take. The superheaters are placed at the passage from the first to the second pass, after the gases have crossed the tubes once and before they cross the second time, so that the temperature is very much higher than in the case of the older types of superheaters, where they were placed in the up-take like a feed-water heater. The experiments which have been made on these boilers under various rates of combustion show that the temperatures where the superheater is located, when burning from 30 to 35 pounds of coal per square feet of grate, would be about 1,000 degrees F., while the temperature of saturated steam of about 200 pounds is about 388 degrees F. There is thus a good difference in temperature, so that a considerable degree of superheat is obtained with a moderate amount of superheating surface. There are still the second and third passes of the boiler to be acted upon by the hot gases, and the only effect is to reduce slightly the temperature of the gases in the up-take. In other words, the efficiency of boiler and superheater is at least as great as that of the boiler alone.

The examples we have given of the navy vessels, of the *Creole* and her sister ships, and the *Wallace*, with and without superheat, all show results as measured in coal, while the *Idalia* experiments give them in water. None of these experiments has the conditions absolutely ideal for determining with extreme accuracy the exact amount of gain due to superheating, because other items vary besides the extent of superheat. What practical men desire to know, however, is not results to the last decimal point, but to be reasonably sure that there is a decided gain due to superheating, and this, we think, has, from the data given, been shown beyond controversy.

We have already mentioned one of the benefits which has been found in land service where superheated steam is used with turbines, and, obviously, thoroughly dry steam, as against very moist, would be a blessing in reciprocating engines, so that this, of course, is another benefit of superheating. On board ship, where there are so many auxiliary engines scattered over a large area, and many of them simple cylinders following full stroke, it can readily be seen that the use of superheated steam ought to be conducive to a great increase of economy. Unfortunately, if tests of this kind have ever been made by the Navy Department they have not been published.

It now remains to mention some of the drawbacks, or rather matters which have to be attended to, if the use of superheated steam is to be entirely satisfactory. In the central stations and power houses on shore, before the use of superheated steam, many of the valves and fittings in the pipe lines were of cast iron. It was found that superheat of 100 degrees, or higher, caused considerable trouble, due to distortion of the cast iron fittings and inability to keep the valves tight. The general practice now is to avoid the use of brass or cast iron, and the valve bodies and fittings which come in contact with superheated steam are to be of cast steel. Valve seats are made of bronze with a large percentage of nickel or of Monel metal, which is a natural bronze of somewhat similar composition. The navy is now using Monel metal valves and seats. With these precautions, experience has shown that superheated steam up to 100 degrees can be used with great satisfaction as far as practical service is concerned, with no increased cost of repairs and with the decided increase in thermal efficiency which has already been mentioned, and which is so essential in all kinds of naval and merchant marine machinery.

The Department of Naval Architecture and Marine Engineering of the Massachusetts Institute of Technology has just received a gift of $750,000 (£154,000) bequeathed by the late Mr. C. H. Pratt, of Boston. This sum will be available for expenditure in two or three years, and according to the terms of the donor's will it is to be used for the purpose of founding or endowing at the Institute the Pratt School of Naval Architecture and Marine Engineering. This gift, coming unsolicited from an unexpected source, is a fitting recognition of the importance which the Department of Naval Architecture and Marine Engineering at the Massachusetts Institute of Technology under the directorship of Prof. C. H. Peabody holds in the world of engineering. This school has constantly attracted students from a great many nations in different parts of the world, which are seeking to establish the industry of shipbuilding. It is the official school for the instruction of the United States naval constructors.

The American Museum of Safety, 29 West Thirty-ninth street, New York, announces that Judge Albert H. Gary, on behalf of the United States Steel Corporation, has presented the museum with $5,000 (£1,023) for obtaining a collection of the best devices for saving life at sea, as a permanent exhibit for demonstration free to the public.

French Destroyer Dague

The French Admiralty is somewhat proud of the successful results obtained with the new destroyer *Dague,* recently built by the Gironde Works, Bordeaux. This destroyer has the following dimensions.

Length over all	255 feet 11 inches
Length between perpendiculars	251 feet 1 inch
Beam	26 feet 1 inch
Beam at load waterline	25 feet 10 inches
Depth	16 feet 9 inches
Draft at the stern	9 feet 8 inches
Trial displacement	730 tons
Full load displacement	770 tons

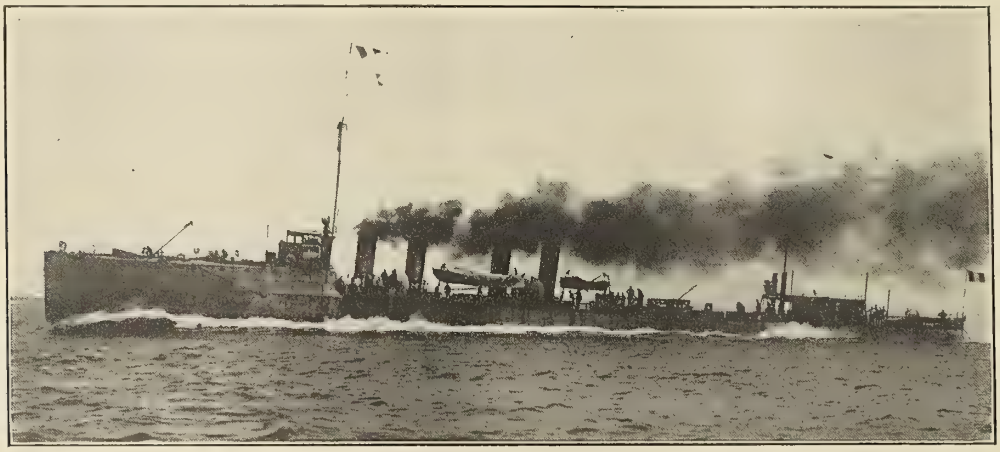
The hull was designed by the Gironde Works, and the turbines supplied by the Brequet firm, which is one of the two builders of marine turbines under French patents. The hull is divided into ten watertight compartments. She has a high freeboard forward, where there is a forecastle deck, which insures better seaworthy qualities than previous types of the destroyers built for the French navy.

Steam is supplied to the main and auxiliary engines by four du Temple watertube boilers, the heating surface of the boilers being 10,668 square feet. Liquid fuel is used, and each boiler has eleven Thornycroft burners. They deliver the fuel under a pressure of 143 pounds per square inch. Thornycroft fuel heaters are also used. The working pressure of the boilers is 173 pounds.

The main engines consist of two independent sets of Brequet turbines, each driving a separate shaft. In each casing are located an ahead and an astern turbine. They have been designed to develop an average of 1,500 shaft horsepower at a speed of 630 revolutions per minute. The contracted speed of the vessel was 31 knots, but during the trials a speed of 33.118 knots was attained. The Brequet turbines are of the impulse type. The power of the steam acting on the blades is balanced by the propeller thrust, any difference between the two being taken up by a small thrust bearing. Each turbine drives a single three-bladed propeller, 7 feet 1 inch in diameter and 6 feet 7 inches pitch.

Each turbine has its own independent condenser, with a total surface of 27,340 square feet. The fuel is carried in the double-bottom and longitudinal tanks on both sides of the boiler rooms. The total capacity of the tanks is 5,700 cubic feet, which gives a theoretical steaming radius of 2,060 miles.

The armament consists of two quick-firing 4-inch guns located forward and aft and four 18-inch torpedo tubes.



NEW FRENCH DETROYER DAGUE

Results of Official Trials

Six Hours' Duration Trial.—Displacement before trial, 733 tons; draft at the stern, 9 feet 8 inches; number of boilers at work, 4; steam pressure at the boilers, 214 pounds; steam pressure at the turbines, 200 pounds; air pressure, 7.6 inches; oil pressure at the burners, 142 pounds; number of revolutions, 667; contract speed, 31 knots; mean speed for six hours, 33.118 knots; oil consumption as per contract, 12.50 tons; oil consumption on trials, 11.15 tons; consumption per square foot of heating surface, 1.22 pounds; miles per ton of fuel, 2.83.

Eight Hours' Consumption Trial at 14 Knots.—Displacement before trial, 734 tons; draft at the stern, 9 feet 8 inches; number of boilers at work, 2; steam pressure at the boilers, 200 pounds; air pressure, 1.16 inches; pressure of oil at the burner, 58 pounds; number of revolutions, 244.16; speed as per contract, 14 knots; speed on trial, 14.3 knots; consumption per hour, 1.03 tons; consumption per square foot heating surface, .02 pound; miles per ton of fuel, 14.

Hydraulic Dredge for Canal Digging

A 15-inch hydraulic dredge was recently designed and built by the Norbom Engineering Co., of Philadelphia, Pa., for Champion & Co., Havana, Cuba, for general contract work and canal digging. It was principally intended to cut out the Roque drainage canal, and on account of the very shallow waters encountered at different places, the hull had to be made very large, compared with the size of the machinery outfit—viz.: with a draft of 34 inches.

AN AMERICAN-BUILT CANAL DIGGER IN CUBA

The main centrifugal pump on this dredge was made in steel throughout, without any other liners than a throat ring, a design which was considered the best under the circumstances. It is direct connected to a compound condensing en-

gine, with cylinders 12 inches and 25 inches diameter and 14 inches stroke, using steam at over 150 pounds pressure and working under a vacuum of 25 inches.

The atmospheric conditions characteristic for the Cuban and other Southern climates made it almost impractical to use the boilers with natural draft without an exceedingly high stack, and for this reason the dredge was fitted with a blower engine for induced draft. This accounts for the short smoke stack shown in the picture.

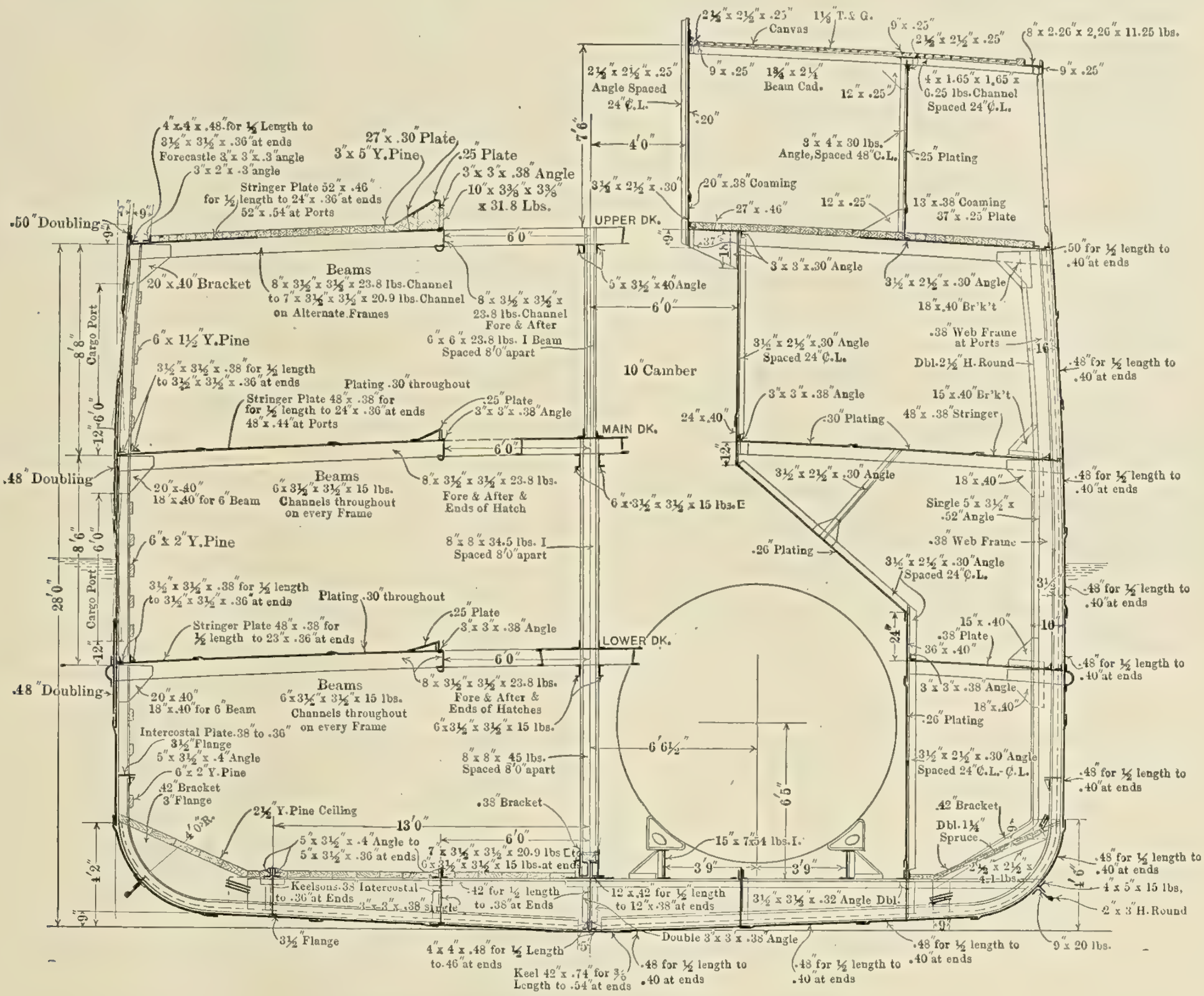
The ladder is of structural steel construction designed for the most severe service, and is self-contained, in that all gearing, as well as the cutter engine, is mounted on the ladder. The engine, which is of a special construction for this class of work, runs fore and aft with the crankshaft athwartship, thus obviating the objectionable features incident to setting the engines athwartship with the crossheads and other reciprocating parts wearing sideways.

This dredge was built in a remarkably short time, considering the fact that the hull had to be built in a locality that was about 30 miles from the nearest railroad, and all machinery and material had to be transported over the poorest kind of roads by ox teams. The contract for the machinery and fittings was placed with the Norbom Engineering Co. in the latter part of June, 1911, and the dredge commenced operations in Cuba on December 23.

With a new crew, most of whom knew little of dredging operations, the dredge is making an average output of about 2,800 cubic yards per day, a performance which was most remarkable, considering the nature of the material, the specific gravity of which averaged 2.3 to 2.6.

Steamship Henry Williams

The steel screw steamship *Henry Williams*, built by the Harlan & Hollingsworth Corporation, of Wilmington, Del., for the Baltimore & Carolina Steamship Company, was launched on April 2. The vessel is built of steel throughout, and is of the awning deck type, having complete steel main and lower deck, while the awning deck is sheathed with wood. She has a straight stem and elliptical stern, and is rigged as a two-masted schooner, having a steel deck house for officers amidships around the engine and boiler enclosures, the latter being of steel. The crew's quarters are located in the forecastle. There are four hatches on the main and lower decks, and one hatch and also an over-all hatch on the awning deck. There are two cargo ports through both sides between the upper and main decks, and two cargo ports through both sides between the main and lower decks, also over-all ports and a hatch with wood covers.



MIDSHIP SECTION OF FREIGHT STEAMER HENRY WILLIAMS

The dimensions of the vessel are as follows: 241 feet long over all, 230 feet between perpendiculars, 229 feet 6 inches Lloyd's perpendiculars, 39 feet beam, molded, 28 feet depth, molded, clear headroom between decks 8 feet. She has been designed for freight service only, and will carry 1,500 tons on a draft of 15 feet.

The propelling machinery consists of a single triple-expansion engine, having cylinders 17 inches, 27 inches and 44 inches diameter, with a stroke of 30 inches, steam being supplied by two cylindrical return tube boilers, 11 feet 3 inches diameter by 10 feet 9 inches long, working at a pressure of 180 pounds per square inch.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

A Peculiar Mishap

Carelessness in handling the overboard discharge, according to unofficial statements, was the cause of a peculiar mishap which sent the freight steamer *Tampico,* of 1,451 tons net, to the bottom of the Seattle harbor recently. At the time the *Tampico* was loading her bunkers. As her stern went down she began to fill and the united efforts of her pumps were unable to stop the inflow. Aid was summoned, but sufficient pump capacity could not be secured to stop the intake, and as the water rose it soon covered the *Tampico's* furnaces, extinguishing the fires. By this time it was seen that nothing could prevent the vessel's sinking, and consequently she was towed a short distance away, where she gradually settled in about 30 feet of water, only a short distance from shore and in the center of the harbor. Difficulty was experienced in salving the ship and extensive repairs were necessary on account of damage to the hull.

STEAMER TAMPICO SUBMERGED IN SEATTLE HARBOR

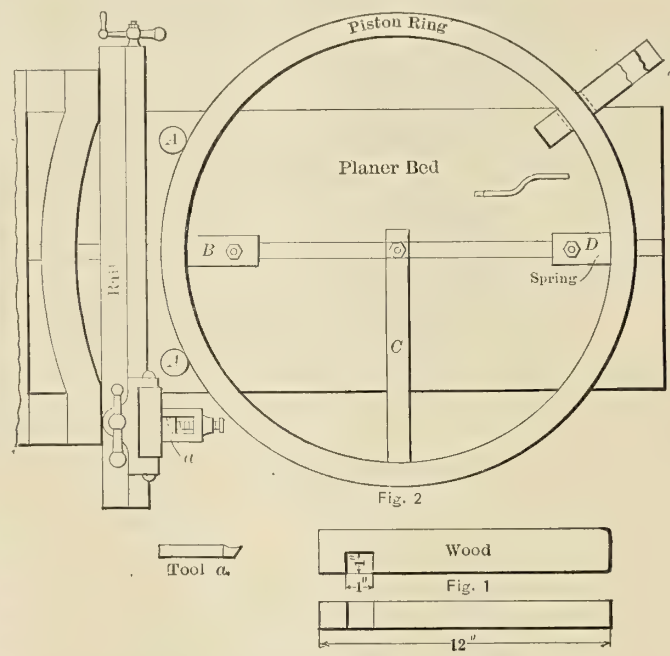
Seattle, Wash. R. C. Hill.

A Piston Ring Planer Job

The other piece I wrote for you got me into a lot of trouble. I was proud as the captain's parrot when it catches a lizard when I got the copy of International Marine Engineering and saw what I wrote all in print, and I read it over to our "third," who is a Scotchman, and who is the only one I guess in the world—they are generally firsts. He would be, too, if he didn't patronize the "boozitoriums" so much when he goes ashore. He said it was "main fine"; but when he saw the sketch we had words, and I had to punch him until he said "'nough," and I got fined a week's pay. You people must be dandy draftsmen to do work like that!

Our chief ain't a Scotchman but a Portugueser, and he is as good as goes, and weighs close on to 200 pounds, and speaks English kinder small, but he is all right. I guess if he had lived back some years he would not have been an engineer but some other kind of a pirate.

What I was going to tell you about was our fitting new rings in the intermediate. We had trouble with the intermediate rings, and the chief told me to get out the spares while he was getting the cylinder head off, when we next got into port, and as soon as we did I looked up the rings. There were four of them. But as soon as I took a look at them I saw we were in a fix, because they were finished outside and inside and one edge all right but the other edge was rough—left just as it had been cut off. Well, to file up a ring like that didn't promise a very good job, so back I goes to the chief and tells him, so he wouldn't break the joint on the intermediate. But he said, "It is goot so, we turn them up ourselves." I thought the sun had got into his head, but I just nodded and went after the rings again, and on my way met the "third," and told him about it, and he said, "Mon, alive! has he took to drink?" We had a dinky little lathe aboard, about 14-inch swing, a small drill press and an old-fashioned planer with a bed about 18 inches wide and 36 inches long. When I got back with the rings the chief had got the cylinder opened up; he took the rings and looked them over, and pointed to something I never saw before. It was a space on the edge of the ring stamped with a steel stamp, "cut this piece out," with two slanting marks on each side of this. Now, that was first-class, as you knew just what you had to cut out to make the rings butt up nice together. I wish other people did this, too.



PISTON RING MOUNTED ON THE PLANER

Back of these snap rings there was a sort of corrugated strip of spring steel. Now, what the chief did was to get the carpenter to make a wood piece out of some good, hard stuff like my drawing, Fig. 1. You bet I didn't ask any questions, but just kept looking on to see how he would turn up a 20-inch ring on a 14-inch dinky little lathe; but he didn't try. He made two studs and put them in the planer bed about like my sketch, Fig. 2, at *A, A;* then he made a stop like *B,*

and another one like C, and a light spring like D. He took a planer tool and annealed it and planed it off on the edge, so it would go into the planer tool post and have the cutting edge point across ship instead of fore and aft. When he got all these things ready he laid the ring down on its good side, as shown in my sketch, on the bed, and brought it up against the plugs A and A; then he brought up the strap B just so as to hold the ring without shaking and not let it bind; then he bolted it up fast. He did the same with the long stop C; he had made the ends of these nice and smooth with a file; then he tightened up on the spring D just enough to feel, and I kept watching him with a bunch of waste in my hand and an oil can handy.

By this time the "third" had brought up the tool which he had been hardening, and he stood by. The chief took the tool and put it in the post, and hooked over the piece of wood on the ring about as shown in the drawing. Then he put the tool into the post and brought it over by the cross feed until it stood about at A; then he worked the bed back until the edge of the tool, if fed across, would cut a little beyond the inside of the ring; then he lowered away on the tool; at the same time he gave a pull on the wooden handle, and, of course, this turned the ring and kept feeding down till the tool just began to cut; then he kept yanking on the wooden handle, pulling the ring around and around, and, of course, the tool took a chip all around the ring.

By feeding across he pretty soon got a good, smooth cut on the ring. I caught on to the idea and so did the "third" right off, and he gave me the other rings to do, and I made a good job of them. They only needed a little scraping, after we had sawed out the piece, to jump them over the piston, and that finished our trouble.

Now, my dear Mr. Editor, for the Lord's sake don't make my drawing look so nice, or that "third" and I will mix it up again, and I got my suspicions that he and the first water tender are practicing sparring, and I had all I could do the last time with him and now he is letting booze alone, so no more at present. Trouble.

The Presence of Salt in Water

The use of the salinometer is, of course, a necessity well known to every sea-going engineer. But it is a matter of considerable importance and interest to know, when working with quite fresh water in the boilers, if any sea water gets introduced. The ordinary salinometer test is, not to say the least of it, a delicate one, and is only approximate for a small quantity of salt. Tasting is a rough and ready method, but I am afraid we are not all fitted with sensitive palates.

One gallon of sea water contains 6 ounces of solids, and this shows as 1/32 on the salinometer. That is, a single division on scale represents 3½ percent, so that the instrument cannot be considered quantitative in a chemical sense.

A test that will infallibly detect the presence of 15 grains of impurity per gallon, *i. e.*, one part in 4,700, or .02 percent, is by using nitrate of silver. To one ounce of suspected water add 2 drops of nitric acid; stir, add 1 drop nitrate of silver. If salt is present, there will be a white precipitate, which will darken on exposure to light.

A recent analysis of sea water gave: Chloride of sodium, 2.60 percent; chloride of potassium, .07 percent; chloride of magnesium, .28 percent; sulphate of lime, .11 percent; sulphate of magnesia, .26 percent.

The insoluble scale is produced by the sulphate of lime, which deposits at 287 degrees Fahrenheit to 310 degrees Fahrenheit, equal to 30 to 35 pounds pressure. Chloride of magnesium decomposes at ordinary boiler temperatures, giving rise to active hydrochloric acid in the water. Light should be excluded from the bottle containing nitrate of silver.

London. A. L. Haas.

Navigation Under Difficulties

In the accompanying unique photograph is shown a stern view of the steamer *Watson*, of the Alaska-Pacific Steamship Company, as it appeared when the *Watson* was hauled out in drydock at San Francisco after a harrowing experience while bound from Puget Sound with freight and passengers for San Francisco. En route the *Watson* ran into a terrific storm from the southwest, accompanied by an unusually high sea. Suddenly the rudder carried away and with it went the rudder post and skag. Whether a sea broke off this gear or whether some submerged obstruction caused the damage is not known. However, the vessel was so skilfully maneuvered that there was no panic among the 100 passengers and the liner arrived safely at San Francisco, after steering 400 miles with the balance of the rudder. The vessel was drawing 18 feet at the time of the accident. The break in the rudder occurred at the 15-foot mark, so that the vessel was steered over 400 miles with but 3 feet of the rudder submerged. It required careful handling to do this, especially in the face of unusually bad weather. Capt. E. P. Bartlett and Chief Engineer Thomas McGrorey have been highly complimented by their owners for the splendid manner in which they did their work. Being equipped with wireless, news of the *Watson's* plight was sent ashore and tugs were awaiting the vessel to assist her through the heads at San Francisco harbor. She made her port only about twelve hours behind time. R. C. H.

DAMAGE TO STEAMER WATSON

A Preventative of Scale and Corrosion in Boilers

The question has occurred to me, why do so many of the brother engineers still persist in using strong chemicals to prevent internal corrosion and for the removal of scale from boilers? I have had a great deal of experience on land and at sea, and have found that chemicals that are strong enough to loosen and dissolve old scale will also attack the boiler itself. They will eat the flange packings in your steam line, destroy the piston rod packing and sometimes affect the rod itself. Now I had an experience some years ago which taught me a lesson. It taught me that there was a cheaper and more efficient way of removing scale and preventing same from forming than the use of strong chemicals.

We had just finished cleaning boilers after a lay-off of several weeks. I sent one of the firemen up over the tops of

the boilers to get a small bag of graphite. He let the bag drop on top of one of the boilers, spilling about half of the contents of the bag, or about 20 to 25 pounds, down through the manhole and into the boiler. I thought at the time that it could not hurt anything, so I did not bother to clean it out, but forgot the incident and did not think of it again until I had it brought to my mind four or five months later, when we opened up the boilers for cleaning again.

I went through two of the boilers and found them in about the same shape as before. In between some of the tubes the scale had formed in a solid mass. On the shell and crown sheets there was from 1/16 to ⅛ inch hard scale. I put a couple of men in each boiler to scale and clean them, and I went on to the next boiler. You can imagine my surprise when I went into No. 3 boiler (on the same battery using water from the same source) to find it almost entirely free from scale. What had settled in the bottom was soft and could be crushed in your hand. Most of it could be washed out with a hose. I did not know what to make of conditions as I found them until I came out with a handful of sediment I had gathered up as I came out. Upon examining this I found it was mixed with graphite, and then I remembered the incident when the graphite was spilled in the boiler.

I have used graphite ever since as a preventative of internal corrosion and to prevent the forming of scale. The graphite I have used has left the boilers clean and does not impair the boiler, packing or engines. No more chemicals for mine. A boiler graphite that protects boilers, engines, etc., is good enough for me. W. V. Ford.

Norwich, Conn.

Fitting a Combustion Chamber Patch

A small steam schooner came to port that was under charter to make a trip to Alaska. The local boiler inspector was to make the annual inspection of the boiler, which was fourteen years old. When they applied the hydrostatic pressure everything around the boiler proved to be tight, no leaks of any kind developing, although I might add that a few rivets were calked and some tubes rolled before the inspector looked it over.

Satisfied with this part, the boiler was emptied and drained out and a thorough inspection made inside, and, barring a very slight pitting, the boiler was in very good condition. The inspector then ordered a drill test of the boiler on the shell at the waterline and at the bottom of the boiler and in the bottom of the combustion chamber wrapper sheet. The first drill tests showed the original thickness, while the combustion chamber had thinned down from ⅝ inch original thickness to 5/16 inch in one place. This was all on the fire side, while the under or water side showed evidence of grooving. I attributed this condition to allowing wet ashes to accumulate in the bottom of the boiler while the boat was out of use.

The inspector ordered the working pressure of 135 pounds cut down to about 95 pounds, and, as they did not want to lose the charter, they asked for and received permission to patch the bad part, which job was immediately undertaken by the boiler shop. I went down to the boat and looked the job over, deciding to renew the bad section on the bottom, which extended 27 inches on each side of the bottom center and included cutting out forty-four 1⅜-inch stay bolts. I also decided that it would be easier to scarf each of the four corners of the old wrapper sheet than it would be to scarf the new plate and slip it under the old pieces, as we would not have to cut out an additional row of staybolts on each side or as many rivets. We would also do away with heating the patch in the corners, which would be very apt to crack the old plates. Deciding on this, I marked the piece to be cut out, and also marked a 2¾-inch by 5¾-inch hand hole on the back head opposite the two lines to be cut, the same to be used in cutting part of the old wrapper sheet, to pass rivets through, etc. I marked the plate allowing an extension for the scarf on each of the four corners.

In the meantime, we had an air line with a manifold, so as to hook on about four air hose lines, and an electric wire for portable lights installed aboard the boat. I started one boiler maker in the combustion chamber to cut across the width on each side, another on the back head to cut out the hand holes and the back end of the wrapper sheet, the first boiler maker going in the boiler under the furnaces and cutting the front ends. He then cut off all the rivet heads to be cut out inside the combustion chamber and backed the rivets out. We then started in to cut out the staybolts, as follows: We split the nuts with a coal chisel and button set and nicked the bolt close to the wrapper sheet, and hitting the bolt on the end a few hard blows with the button set they readily broke off. We then drilled each bolt about ¾ inch deep, or just through the wrapper sheet. We then got an extra long chisel bar that extended through the front manhole and broke the staybolts off close to the shell. This being done, it allowed the piece we had cut out to drop down, and by turning and twisting it around it was readily taken out of the furnace and up to the boiler shop, the furnace front being previously removed.

One boiler maker started in to scarf off the corners by chipping, while another started in to drill out the staybolt ends in the shell from inside the boiler. In the meantime, we had straightened the plate we had cut out, and, getting a plate of flange steel, we marked off a new piece by placing the old one on top and marking off all the old holes, leaving the new holes in the seam out, which holes were being drilled in the boiler. We then proceeded in the ordinary way to drill, plane and roll the plate, having made a sweep from the old piece before straightening. By this time the scarfing was all done on the boiler, and I made a templet of it on each of the four corners, as they were thinned down by chipping and varied slightly, and using a hole as a tell-tale point so as to have the pocket in just the right place.

We next had the plate taken to the fire, where we heated it and worked each corner to conform to the templets, already mentioned. In putting in these pockets we got a small steel wedge, which was just about the size of the scarfs on the old section. We did this work to save heating and fitting on the boiler.

Having drilled the seam holes and countersunk them, also all the holes in the heads, and having cleaned all the staybolt holes out, we placed the new plate in position, and after bolting it up and drilling the rivet holes through the seams and the ends in position we were ready to rivet it up, as it required no fitting or heating whatever. This was quite an item, as it would surely endanger cracking the old heads were we to heat the corners. The rivets were driven by hand with a deep countersink, the holder-on having quite a job reaching in under the back end, as he laid under the furnaces, where there was about 5 inches water space at the bottom. The job was calked on the combustion chamber side only.

We next put in the staybolts; the old ones were 1⅜ inches, but we put in 1½-inch bolts, as it is always better to put in a larger size on cutting out staybolts, as it is next to impossible to get good threads unless you do. We calked the bolts with a gouge-shaped calking tool, wrapped a couple of turns of asbestos string around it at the bottom, put a little red lead putty over that, and put the nuts on.

After thoroughly cleaning out the boiler, we closed it up again, and, filling with cold water, we applied the pressure. Everything being satisfactory, we sent for the inspector,

who, upon examining the work done, pronounced the boiler in good condition.

The old method of doing a job of this kind would be to scarf all four ends of the new plate, cut out four additional staybolts on each end and about twenty extra rivets, in order to spring the old wrapper sheet apart; then it would be necessary to heat and set up all four corners, and, at the best, you could not make a perfect job out of the back ones.

The above repairs were completed in 13 days (8½ hours per day), divided up as follows:

Four days cutting out the patch and forty-four staybolts.

Two days scarfing and trimming.

One day drilling.

Two days getting the patch out in the shop.

One and one-half days fitting the patch in place and drilling the seams.

Two days to rivet it up.

Two and one-half days tapping holes and putting in staybolts.

One day testing.

Plate was ⅝ inch by 30¾ inches by 60 inches; ⅞-inch rivets.

Average of three boiler makers and two helpers on the boat, all the work being done with air tools.

We, very shortly after completing this job, had a similar one on another steam schooner; but, in order to get at the staybolts on the bottom of the shell, we found it necessary to jack up the boiler, which involved quite a job of disconnecting steam pipes, etc. We did not cut the hand holes on the back head for this job, as we were able to cut out the old piece by using extra long chisels, having profited by the experience of the first job. JAMES VINCENT.

Crosshead Troubles

The cross-head shoes of marine engines do not generally give much trouble when the bearing surfaces are well oiled, nor do they require much attention. Formerly many cross-heads were fitted with brass shoes, but now, however, they are, as a rule, made of steel castings lined with white metal. This is quite satisfactory, yet the best results can be obtained by the use of cast iron, *i. e.,* cast iron running on cast iron. This construction requires more oil, but it wears less. At times cast iron will give trouble where white metal-lined shoes will not, as the following actual occurrence will show:

The cross-heads of the compound engine of the steamer *W*——— were made with cast iron shoes running on cast iron guide plates. On the trial trip the cross-heads warmed up and finally heated, and it was found impossible to cool them down by using a lubricant made of oil mixed with white lead, which is an excellent help in such cases, as most engineers know. They soon became so hot that sparks could be seen on the guide plate, and the engine had to be stopped. The shoes were taken off, which required considerable labor, as the cylinder head covers had to be taken off and the pistons unscrewed in order to reach the cross-heads. Several hard places showed on the shoes, which were scraped away. After all was again replaced the engine was started, and the trip completed, but the shoes gave the same trouble later.

It must be clear, therefore, that this form of cross-head is not the right one, as when it warms up even a little it will swell until it grips between the columns. When the shoes are lined with white metal on both sides they do not give this same trouble of gripping, but the wear is considerably more.

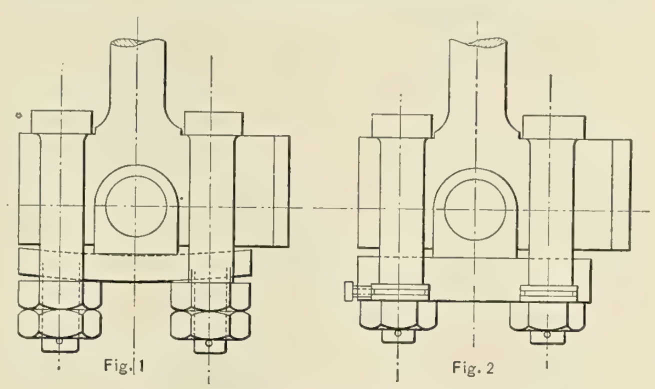
Often the astern shoe face is fitted with white metal lining and the go-ahead shoe is not. This seems to work very well. Cast iron on cast iron demands a larger surface and better oiling, but many engine builders object to its use, but this construction is not best in all cases, as the following will show:

The eccentric straps on an engine were not lined with white metal. On the trial trip of the vessel one of these gripped on the eccentric sheave, causing a breakdown. Here the surface is small. After this breakdown the builders of the engine always lined the eccentric straps with white metal.

It is often said that steel cast slippers running on cast iron guide plates give good results, and the writer knows several engines so designed and recommends this construction strongly. For naval and yacht engines all parts are, as a rule, made as light as possible. The stress on the bolts, etc., are generally higher in this class of work than on commercial engines. Even a few ounces in weight is saved, and it is often a source of discussion between designers of engines whether or not the hot wells, pipes and tanks and other receptacles for water are not made far too large for what is required, and too little attention is given to these causes of weight and superfluous amount of water to be carried.

Bolts are often made strong enough to resist the tensile strength, but this is not all that they, at times, have to be figured for. Other demands must be remembered, as is illustrated in the following:

One of the cross-head bolts of a yacht engine on the high-pressure cylinder broke. A new bolt was supplied, which again broke. Then two new bolts were made ⅛ inch thicker than the originals; but one of these soon broke, and a spare bolt was put in which held for some time, but when the bearing was taken up this bolt was found to be bent and had to be replaced. As in similar engines bolts of the same size were found to have held satisfactorily and gave no trouble it was clear that something must be the cause. It was suggested that water had been trapped in the high-pressure cylinder, causing excessive strains, and accounted for the breaking of the bolt; but the engineer investigated the matter carefully and found the cause of the mystery, which was due to the keeper of the cross-head bearings being too thin. This



CAUSE OF CROSSHEAD TROUBLE AND ALTERATIONS MADE

is illustrated in Fig. 1, and it shows how the keeper was bent when the bolts were tightened up. This subjected them to a severe bending stress, and this stress, combined with the tensile stress, was too high for the bolts to withstand, so they broke.

The cross-heads were altered, as indicated in Fig. 2, the caps being made much thicker, and the nuts were also "necked," as there was no room for putting on check nuts. After being in service some time it showed that this arrangement obviated the difficulty entirely. D. K.

Harland & Wolff, Belfast, are rapidly completing the fourth largest vessel in the world for the Holland-America Line. This vessel is 740 feet long, 86 feet beam with a gross tonnage of 32,500 tons. The designed speed is 17 knots.

Review of Important Marine Articles in the Engineering Press

His Majesty's Torpedo Boat Destroyer Fury.—One of the twenty torpedo boat destroyers completed during the last fiscal year for the British Admiralty is the *Fury*. The length, breadth and depth of the hull are 240 feet, 25½ and 15 feet 7 inches, respectively. The forecastle and bridge are built high with the object of maintaining a high speed in heavy seas. Weight of hull is 310 tons and displacement on draft of 7 feet 10 inches is 770 tons. Yarrow boilers fired by oil fuel have given smokeless combustion on trial. The engines are Parsons turbines, designed for 13,500 horsepower, from which 27 knots speed was expected. On trial, however, the maximum shaft-horsepower was about 14,000, and the mean speed during the eight hours was 27.82 knots. At 13¼ knots speed, using 1,000 horsepower, the fuel consumption was such as to give a radius of action of 2,600 miles. 350 words.—*Engineering,* March 15.

Steam Trials of H. M. S. Thunderer.—The battleship *Thunderer* has successfully passed all her steam trials and is expected to be finished by her builders, the Thames Iron Works & Shipbuilding Company, by May. The length is 545 feet, beam 88½ feet and displacement tonnage 22,500 tons. The boilers are of the Babcock & Wilcox type, and the main propelling machinery consists of Parsons turbines. On the full-power trial the engines averaged 299 revolutions per minute and 27,416 shaft-horsepower, while the coal consumption was 1.78 pounds per shaft-horsepower-hour. The machinery throughout worked satisfactorily. 350 words.—*Engineering,* March 15.

The Navy Estimates.—A review of the recently-published naval estimates for the coming year for the British Admiralty. In the budget is a statement from the First Lord of the Admiralty that "These estimates have been framed on the assumption that the existing programmes of other naval Powers will not be increased. In the event of such increases it will be necessary to present supplementary estimates both for men and money." The estimates call for four large armored ships, eight light armored ships of a new type, twenty destroyers and a number of subsidiary craft. Tabulated comparisons are made throughout the paper of the budgets made in previous years with this one, and comment is favorable on the course of this year's action. 3,300 words.—*Engineering,* March 15.

The Ocean-Going Oil-Engined Ship Sembilan.—After having built the successful Diesel-engine-propelled ship *Vulcanus,* the Werkspoor Works at Amsterdam have recently completed their second vessel of this type, the *Sembilan*. She is 150 feet length on load line, 26 feet breadth and 9 feet 6 inches depth, with single screw, driven by a three-cylinder, Werkspoor Diesel marine type engine, running at 200 revolutions and developing 200 brake-horsepower. On regular voyages aggregating 1,780 miles her average speed was 7½ knots and the fuel consumption was 11.7 pounds per nautical mile. The cylinders are water-cooled but the pistons are air-cooled, both arrangements being said to work successfully. A novel feature of the engine is a patented design of cylinder whereby the piston may be examined without disconnecting piston rod or connecting rod. This is accomplished by making the cylinder with a solid head, but having a jacket bolted on the lower end, which is removed and the piston exposed for examination. The article is illustrated with drawings of general arrangement of the ship and four assembly drawings of engine. 1,300 words.—*Engineering,* March 15.

The Austro-Hungarian Battleship Tegetthoff.—Short notice and photograph of launch of the new Austrian dreadnought. Principal dimensions and specifications are: Length, 495 feet; beam, 89 feet; displacement, 20,040 tons on 26 feet draft. Machinery consists of Parsons turbines and Yarrow boilers. The vessel mounts twelve 12-inch guns and sixteen 3-inch and twenty-four smaller weapons. During the earlier stages of construction great secrecy was maintained concerning the vessel. 225 words.—*Engineering,* March 29.

Some Military Principles which Bear on Warship Design.—By Admiral Sir Reginald Custance, K. C. B. A study of naval tactics bearing on warship design, principally the subjects of gun sizes and the value of armor. The author starts with the statement that a ship of war embodies the tactical and strategical ideals of the age in which she is designed and built; that it is the business of the naval officer to examine these ideals and the military principles underlying them, and the part of the naval architect to embody these in design. He then proceeds to the examination of present-day ideals of warship construction, taking as object lessons decisive naval engagements from the time of the *Monitor* and *Merrimac* down to the Russo-Japanese War. In the study of weapons, of the three—gun, ram and torpedo—he takes time for a discussion of the gun only. The study of armor is as completely carried out. From the history of naval engagements where armor played an important part the author has derived conclusions which point to its lessened value under the latest conditions of naval fighting. As for the rest, he urges the importance of many guns and many men, even if guns of the largest sizes must be dispensed with, since, besides the moral effect, large calibers are not always effective in action. He presents tabulated data of fighting ship elements. 4,200 words.—*Engineering,* March 29.

Turning Circles.—By Prof. William Hovgaard. An investigation into the behavior of ships while turning circles under given standard conditions, which are as follows: All the ships were of the twin-screw type except one, which had four propellers. The propellers were placed in the ordinary position relative to the rudders. The rudders were of ordinary form, balanced or unbalanced. Before the rudders were laid over, both propellers were going ahead at the same speed and the valves of the engines were not touched during the trial. The rudder was laid at or near its maximum angle. An analysis of trials made upon a number of Danish warships under the supervision of Capt. A. Rasmussen, and upon a few typical vessels of the United States navy, of all sizes and types. The results are tabulated, showing sketches of forms of stern profile and rudder and giving all data bearing upon the investigation and the results which are given under terms such as radius of turning circle, speed during turning, ratio of speeds, rudder pressure, drift angle and pivoting point. The importance of this information is enhanced by the fact that this is the first contribution to this field of knowledge which gives anything like complete data on the action involved. 2,600 words. Illustrated with diagrams.—Paper read before the Institution of Naval Architects.

The Law of Comparison for Surface Friction and Eddy-Making Resistances in Fluids.—By T. E. Stanton, D. Sc. An attempted verification, by further experiment, of Mr. W. Froude's work on these topics. The work herein described is based upon the experiments and results obtained by Mr. Osborne Reynolds on the subject of friction in pipes of the flow of water. These were supplemented by experiments on the resistance of wooden models of dirigible balloons of different sizes subject to pressure of both water and wind. The coefficients of friction obtained were such as to verify the accuracy of the law of comparison for friction and eddy-making resistance. The paper is entirely theoretical in its nature and scope, and is applicable to practical use only upon

its merits as a report of laboratory experiments based upon assumptions made common to such work in hydrodynamics. 2,500 words.—Paper read before the Institution of Naval Architects.

The Salvage of the San Giorgio.—The first paper of a serial dealing with the stranding of the Italian armored cruiser *San Giorgio* on the Gaiola Shoal Aug. 12 and the subsequent salvage operations. These were quite remarkable considering the damage done the vessel and the position in which she was placed. At the time of the accident she was steaming at a speed of about 13 knots. A rocky ledge was struck amidships, and, the bottom being broken open in several places, the sea rushed into the forward and central compartments. The day following a council was held by officers in charge of the salvage, and the following plans laid down for carrying out of the work: The lightening of the ship; expulsion of the water; cutting away the reef; use of external lifting appliances. These four classes of operations were to proceed simultaneously, together with such other measures as would insure the safety of the work in case of bad weather, the prevention of extension of flooding of the vessel, and a measure of the progress of the work. For carrying out the first plan preparations were made for taking out the weights of guns, turrets, conning towers and armor. Later, the two forward funnels were sent ashore. For the purpose of expulsion of water, pumps were placed to draw from each compartment, and these were made tight as the water was rapidly removed. As several compartments were emptied and hermetically sealed, means were also provided for forcing water out of other compartments by forcing compressed air in. The article is illustrated by photographs and several very good drawings showing the condition of the bottom. 6,000 words.—*The Engineer,* April 19.

The Salvage of the San Giorgio.—Second paper. This installment deals with cutting away the rock of the reef and the use of external lifting appliances, which finally enables the ship to be floated and brought safely to a dockyard, where she has been restored to the navy. Illustrated with drawings and photographs. 3,500 words.—*The Engineer,* April 26.

The Loss of the Titanic.—By Prof. J. H. Biles. A comparison of bulkhead spacing in typical Atlantic liners with reference to the requirements of the bulkhead committee of the Board of Trade. There is presented tabulated data of spacing of bulkheads, height and strength, together with diagrams of different ships, showing placing of the same. One example is given of very effective bulkhead construction, tested by a previous accident somewhat similar to that of the *Titanic.* From that time until the present this vessel has not been equaled in that respect. Her owners have since found her arrangements unhandy and wasteful of possible passenger space, and in subsequent vessels for the same line different arrangements were made for height of bulkheads and the storage of fuel. This is a good example of how public sentiment is active immediately following a calamity, gradually becoming less acute as time passes with no immediate repetition of the horrors of such a wreck. The conclusions reached by the author are that all bulkheads should be carried as high as possible, and that the decks should be made effectively water-tight. 3,700 words.—*The Engineer,* April 19.

Load-Extension Diagrams Obtained Photographically with an Automatic Self-Contained Optical Load-Extension Indicator.—By Prof. W. E. Dalby, M. A. A description of an apparatus for taking load-extension diagrams photographically by means of mirrors. These are so adjusted that a ray of light is thrown into the field of exposure of a camera in such a manner as to be proportionate to the load upon a test specimen in a testing machine. In this way the behavior of materials at or near the yield point is plotted permanently for reference or study. With the description of the machine are given several plots showing diagrams of steel of different carbon content. Illustrated. Paper read before the Institution of Naval Architects.

Waves and Ship Form.—By Arthur R. Liddell, Charlottenburg. A consideration of waves and their effect on hull form dealing with general principles and the general characteristics of hulls for different conditions of service. Toward the last of the paper the determination of longitudinal bending moments among waves is considered, including the Smith correction applicable to wave height as communicated to the Institution of Naval Architects. A table is given for use with the Smith correction whereby the application is made easier. 3,300 words.—*The Engineer,* April 5.

The Revenue Cutter Service.—The recent recommendation to have the Revenue Cutter Service in its present form abolished has brought forth a discussion as to the work and efficiency of the service. This article states briefly its history, and makes a good case for the work done by this minor navy under the Treasury Department. Its beginning dates back to 1790, eight years before the establishment of the Navy Department, and from that time until the present the vessels of the Revenue Cutter Service have given good account of themselves in war, in the business of the Revenue Service, as savers of life and shipping property in storm and danger, and in the many commissions of miscellaneous nature that have from time to time been entrusted to their care. 2,900 words, with photographs.—*The Marine Review,* April.

The Ljungström Steam Turbine.—An article illustrated by several photographs and drawings descriptive of the type of reaction steam turbine devised and built by Mr. Birger Ljungström, an engineer at Stockholm, and his brother, Mr. Frederic Ljungström. The machine is a radial-flow reaction turbine, steam being admitted between two disks, and in its passage from their center to their circumference passing between concentric blading rings carried alternately by the two disks. The disks revolve at equal speeds in opposite directions, each disk carrying on the other end of their shafts an electric generator. The relative speeds of each set of blades is thus twice as great as in a standard reaction turbine of equal revolutions and diameter, and thus for equal efficiency the total number of blade rows is only one-quarter as great. Moreover, as there is no split cast iron casing carrying blades or dummy packings, the whole of these parts being mounted on the solid circular disks, the fear of distortion troubles is completely eliminated. This sense of security has encouraged the use of the highest degree of superheat practicable to be used. Two years ago a test machine was built of 500-kilowatt capacity, connected to water brakes instead of to electric generators. It fully realized the expectations of the designer, giving an efficiency ratio of 71.8 percent and a steam consumption of 8.75 pounds per brake-horsepower-hour with initial steam pressure of 172 pounds absolute, with 258 degrees superheat and vacuum of 28.45 inches. Since then another machine of 1,000-kilowatt capacity has been built, connected to electric generators, and is now in successful operation. 4,300 words.—*Engineering,* April 12.

Electric Ship Propulsion with Ljungström Turbo-Generators.—A communication from the inventor showing the advantages of his design of turbine for marine work. Its value for stationary work has already been proven by tests upon a 1,000-kilowatt set in practical operation. On shipboard there would be the added advantage that voltage need not be kept constant. As to efficiency of electrical transmission, 90 to 92 percent is claimed under favorable circumstances. For a 4,500-kilowatt plant running at 3,000 revolutions per minute a thermodynamic efficiency is claimed by the inventor of about 85 percent. For maneuvering, motors coupled in

cascade are recommended for slowing down to one-half or one-third speed, and for other speeds the turbine could be throttled. This system offers higher turbine and propeller efficiencies than mechanical gearing, due to the higher ratios of speeds practicable for use. A complete estimate has been made showing the saving in weight and space, fuel consumption and operating costs for the *Mauretania* using the Ljungström turbo-generators. Diagrams accompany showing relative space devoted to machinery with the present type of machinery and the estimated plant. The author gives calculations for an installation on a torpedo boat destroyer. A comparison of the performance of the Diesel engine with the Ljungström turbo-generator favors the latter, because of its slower speed for the propeller. 3,400 words.—*Engineering*, April 19.

An Analysis of the Claims of the Marine Internal Combustion Engine.—So much has been said recently upon the comparison on general principles of the marine internal-combustion motor with the steam engine that a direct comparison of estimates for specific instances may throw new light upon the matter. This has been attempted in an article under the above title in *The Engineer*, the author choosing three cases for making the test. First was chosen the small launch of about 14 horsepower used for occasional steaming; second, 80 horsepower, as used in small tugs, fishing smacks, barges, etc.; third, 1,100 horsepower as installed in small tramps. Comparative drawings of machinery space required are given for all cases, together with the figures showing costs of installation and operation and the attendant advantages of each. Besides the general statement of results the data are tabulated for convenient comparison. Briefly stated, the results are: For the smallest size the steam outfit costs much more to install but somewhat less to operate, weighs more, takes up less longitudinal space, requires more time to get under way, but is safer and perhaps more reliable. For the next size the steam engine costs about 80 percent as much to install as the other, costs more than twice as much to operate, requires practically the same space and labor attendance and more time to get under way, as was the case in the smaller boat. For the largest size considered the steam engine shows up to a larger disadvantage than in either of the others. Although its first cost is only 70 percent of an equivalent two-cycle oil engine, the fuel cost per unit operating time is more than twice as great, no allowance being made for standby losses. The steam plant will require considerably more space and a larger crew, and will run up larger repair and depreciation charges in a given time. While some items to be considered are largely matters of opinion, others may be fairly well established from experience and data now at hand. 4,700 words.—*The Engineer*, March 15.

Oil or Steam?—An editorial presenting the question of type of propulsive power. Its principal contents are comments upon the article treated in the preceding review, though in its broader aim it tries to interpret the former in its general bearing upon the whole subject. While those comparisons were made with engines to the same specifications, in practice the oil motor would have a decided advantage in running at a higher speed. This would favor economy by the resulting decrease in machinery weight. The question of which type of oil motor is most suitable for marine work is one as yet unsettled. There are good reasons why the two-cycle engine appears to be the coming type, but at the present time mechanical uncertainties delay its general adoption. In closing, the editors favor the broad and general study of the question, taking into account as most important evidence the tried results from both types and letting go as unimportant the elements non-essential or due primarily to the early state of motor development, which was productive of a great variety of types. 2,300 words.—*The Engineer*, March 15.

The Tosi Steam Turbines.—These machines are constructed by Mr. F. Tosi, of Legnano, Italy. The article here reviewed is a description of a 7,500-horsepower turbine installed in a torpedo boat destroyer for the Italian navy. It drives one of twin screws, and is of the mixed type, having six velocity-compound stages followed by a drum carrying fourteen rows of reaction blading. The first of the wheels carrying the velocity compounding blades carry four rows of blades, the others three each. In the same casing a reverse turbine is fitted, it being of the same general type, having one velocity stage of four rows of blades, followed by twelve rows of reaction blading. The turbine works from an initial pressure of 233 pounds gage down to 27-inch vacuum, developing at its maximum output 7,500 horsepower when running at 600 revolutions per minute. The astern turbine is designed to generate 3,450 horsepower at 400 revolutions per minute. Besides the marine turbine mentioned above there is shown and described in some detail a 4,500-horsepower turbine for driving an electric generator. Profusely illustrated with detail and assembly drawings and photographs. 3,400 words. —*Engineering*, April 26.

Fitted Up as Oil Burners.—An illustrated description of the conversion of the three Cramp-built steamers *Sierra, Sonoma* and *Ventura* from coal to oil burners at the Union Iron Works. The general dimensions of the ships are: 416 feet length over all, 50 feet molded beam, 28 feet 3 inches depth to main deck, displacement 9,680 tons on draft of 24 feet. The engines are triple expansion, with cylinders 28, 46 and 76 inches diameter and 48 inches stroke. The boilers are eight in number, 13 feet 6 inches diameter and 10 feet 5 inches length, with total heating surface of 14,975 square feet and total grate surface of 409.5 square feet. The changes incident to oil-burning installation include a general rearrangement of boilers and the use of one stack in place of two formerly used. 720 words.—*The Marine Review*, April.

Communication Between Engine Room and Bridge of Steamships and Some Methods of Controlling the Same.—By J. M. Newall. A complete account of the development of the engine-room telegraph, more particularly the later improvements whereby greater certainty of signals is insured. Shows type of instrument to be used with three engines or turbines, the signals being transmitted to all three by the same telegraph. Several forms of revolution and direction indicators are described and shown, among them the well-known McNab instrument. The Recordicator, an invention of the author, is described in full. This is a combination of several different instruments used on shipboard, and has for its object: to let the engineer working the engines know when he is putting them the wrong way, to signal the bridge the actual working of the engines, to record the same. The value of such an instrument is apparent. 6,500 words, illustrated with photographs.—*The Steamship*, April.

Two Hundred-Ton Electric Revolving Cantilever Crane.—There has been recently completed a very fine example of crane work for the Imperial Japanese navy by Messrs. Cowans, Sheldon & Company, Ltd. This crane, designed entirely by the manufacturers, is of 200 tons capacity, and has been tested with a load of 250 tons. Its working radii are 105 feet for 200 tons, 150 feet for 100 tons and 160 feet for 30 tons. The cantilever is supported on a square tower 50 feet on a side and rising 109 feet from quay to base of circular track. From the center of this the crane reaches out with 170 feet radius on the hoisting end and 95 feet on the motor end. The roller path is 50 feet in diameter. The motors, of which there are five 60 horsepower, one 30 and one 10 horsepower, are of the totally enclosed, series wound, multi-polar type, working on direct current at 220 volts. The crane went through a series of tests in a highly successful manner. 2,300 words and plates of structure complete.—*Engineering*, March 15.

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In referring in these columns several years ago to the possible reduction in steam consumption by the use of superheated steam we pointed out that at that time results from the use of superheated steam with turbines showed that a saving of about one percent of steam consumption could be made for each ten degrees Fahrenheit of superheat. Since then the data which have come to hand have justified this statement, as can be seen from the very complete summary of the available data from marine work in the United States which has been contributed to this issue. The data in this instance, however, include the use of superheated steam with reciprocating engines, and it is interesting to note that equally good results have been obtained from superheated steam with both reciprocating engines and steam turbines. In navy practice, where from 50 to 100 degrees superheating is commonly used, practically the same percentages of reduction in fuel and in steam consumption are obtained. At the last meeting of the Institution of Naval Architects a very interesting paper on the results of experiments with a watertube boiler, with special reference to superheating, was read by Mr. Harold E. Yarrow. His experiments included not only the installation of superheaters, but, what seems of equal importance, the utilization of waste gases for feed-water heating. His conclusions are that there will be a certain gain by the use of superheated steam of from 8 to 10 percent of fuel economy when using 100 degrees Fahrenheit superheat and from 11 to 13 percent gain when using 150 degrees Fahrenheit of superheat in combination with a pressure of 200 pounds per square inch, and also that a further gain in fuel economy can be obtained by an efficient system of heating the feed from the gases after they have passed the generator tubes of the boiler. This, he claims, can be obtained without increased weight, cost, space or upkeep of the boiler installation.

When the submarine first became recognized as an important factor in naval power its effectiveness was limited by the comparatively short range and inaccuracy of the torpedo and by the slow surface and under-water speeds of the vessel itself, its short radius of action, and its uncertain maneuvering powers. It is only about fifteen years, however, since the first practical submarine was introduced, and during that time the range of the torpedo has been increased from less than a thousand yards to about a mile. The speed of the vessel, both on the surface and when submerged, has been doubled, and the radius of action increased so that a submarine can now undertake a long sea voyage without escort. At the summer meetings of the German Society of Naval Architects, just concluded, various proposals for improved motive power for submarines were suggested, the most novel of which was the use of steam machinery in place of the present combination of oil engines and electric power, so-called soda boilers supplying steam when the vessel is submerged. Further results are needed, however, to show the superiority of this arrangement over the present type of installation.

The great courage with which every man on the engine room force of the *Titantic* faithfully performed his duty and went down with the ship has scarcely been referred to in the reports of the disaster. It seems fitting that recognition of the heroism of these martyrs should be made, and it is proposed to erect a memorial of some kind in Southampton, whence the *Titanic* sailed to her destruction.

Engineers all over the world are invited to contribute to this fund. In order to make it come within the limits of the purse of everybody, it is called a Shilling Fund (twenty-five cents), although, of course, contributions of any size will be welcome.

Any of our readers who wish to express their recognition of the great devotion to duty of these engineers can send contributions to Mr. E. J. P. Benn, Publisher, International Marine Engineering, 31 Christopher street, London, E. C., or to Mr. H. L. Aldrich, publisher of International Marine Engineering, 17 Battery place, New York.

Improved Engineering Specialties for the Marine Field

Lackawanna Arched Web Steel Sheet Piling

The characteristic feature of the new Lackawanna arched web steel sheet piling, made by the Lackawanna Steel Company, Buffalo, N. Y., is the curving or arching of the web, so that the mass of metal within the web lies to one side of the neutral axis of the section. Referring to the illustrations, the outer face of the web, or what might be termed the extrados of the arch, is flattened to lie in the same horizontal plane with the extreme outer faces of the members of the interlocked joint. In the piling wall the arches reverse with each pile with reference to the neutral axis of the wall, and the total thickness of the wall at the center of each web is equal to but not greater than the thickness of the wall at the interlocked joint. At the same time, it is claimed, the arched section transmits the load to the supports without as great a tendency to flatten out as found in corrugated sections made of rolled or bent plates.

The haunches of the arch are thickened, giving increased strength at this point against spreading, and also distributing

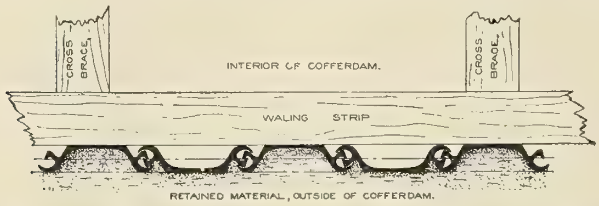


FIG. 1.—TYPICAL SECTION OF WALL OF LACKAWANNA ARCHED WEB STEEL SHEET PILING

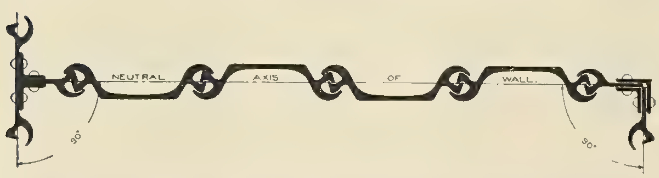


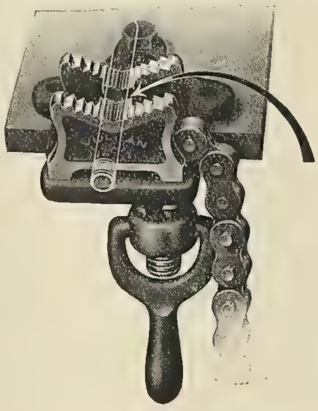
FIG. 2.—LACKAWANNA ARCHED WEB STEEL SHEET PILING ASSEMBLED

the metal in the web with reference to the neutral axis so as to increase the inertia and modulus of the section. From Fig. 1 it can be seen that on each section where pressure comes on the external part of the arch, this pressure is transmitted to the waling timber through the interlocking members of the joint. In those piles where the internal part of the arch is under pressure the pressure is transmitted directly through the metal to the waling timber throughout a wide contact. This bearing surface is greatly lengthened at each edge by the thickening of the arches at the haunches, as stated.

It is claimed that a wall of Lackawanna arched steel piling, in comparison to a similar wall of plain straight-webbed piling sections, all other conditions being the same, has much greater transverse strength, due to the higher section modulus of the individual piling sections and the correspondingly higher resistance against the bending moment produced by the peculiar distribution of the metal. This greatly increased transverse strength permits the building of a wall that is thin and compact in proportion to its lateral strength. It permits a greater vertical spacing between supports or waling timbers for piling of a given weight per square foot, therefore reducing the amount of timber required for safety under a given loading, and thus effecting economy where transverse strength is a primary consideration. Where tensional strength is of greatest importance, as in structures that cannot be braced, the ordinary straight-webbed piling will be found preferable. But for braced structures, where each pile acts as a supported vertical beam, the arched section is claimed to be relatively the strongest and most economical.

Vulcan Chain Pipe Vise

The original Vulcan chain vise manufactured by Messrs. J. H. Williams & Company, Brooklyn, N. Y., has been described in previous issues of this journal. Since this vise was introduced additional sizes have been made which will care for all pipe sizes from 1/8 to 8 inches diameter. The

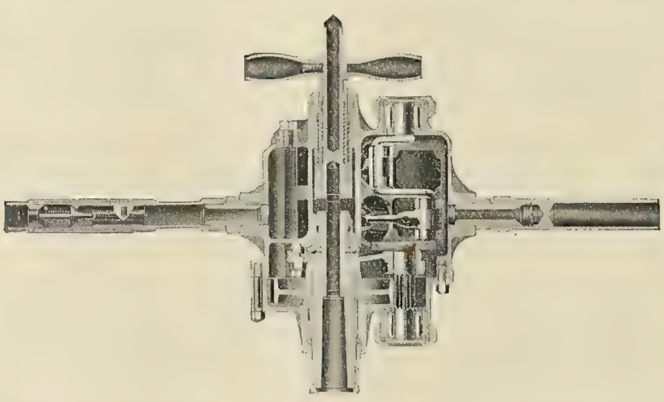


smallest size, which is termed "the baby," shown herewith, is manufactured with an added improvement, consisting of an extended tooth, which enables the extreme of chain grip without bending or injuring the smallest pipe. The vises are made entirely from wrought steel. The drop-forged jaws are of steel tempered for file sharpening.

Thor Roller Bearing Air Drills

The Independent Pneumatic Tool Company, Chicago, Ill., has recently placed a new line of portable drilling machines on the market, known as the Thor Roller Bearing Piston Air Drills.

These machines possess the same general features which were used so successfully in former types of Thor drills, such as Corliss valves, telescopic screw-feed, removable



crank chamber plate, and large air chamber. The size of the spindle in most cases has been increased, but the most radical improvement is in the crankshaft bearings, connecting rods, eccentrics and eccentric straps. The crankshaft has been greatly strengthened, and anti-friction roller bearings are provided for same. The rollers are of ample length and

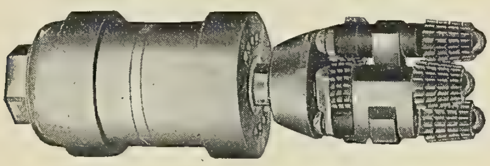
diameter and are retained in a machined brass cage. The bushings have a slip fit into the casing and are hardened and ground. The crankshaft has rounded ends and end thrust against a hardened plate, which reduces friction.

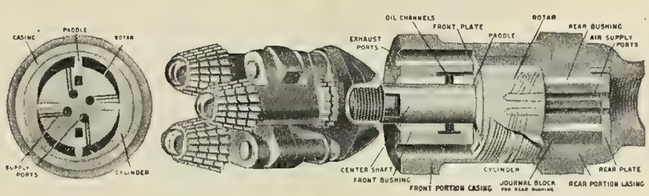
On account of the increased size of the crankshaft and ample size of rollers, the center bearing is dispensed with. The eccentric is smaller in diameter, and being mounted on the crankshaft still further reduces friction.

The toggle and connecting rod used in former types have been replaced with a one-piece connecting rod similar to that used so successfully in the Thor Nos. 8 and 9 close corner drills. Roller bearings are also provided for the idler or planet gears in the compound drills, and an improved shifter mechanism is used on all two-speed machines. The accompanying illustration shows this drill with roller bearings on each end of the crankshaft and one-piece connecting rod.

A New Type of Air-Driven Boiler Tube Cleaner

The air or steam-driven type of boiler tube cleaner has been found the most satisfactory in many power plants because water is expensive or the pressure is too low to give sufficient power to drive a water turbine cleaner. Plants in which these conditions obtain will undoubtedly be interested in a new type of air or steam-driven cleaner recently perfected by the Lagonda Manufacturing Company, Springfield, Ohio. The



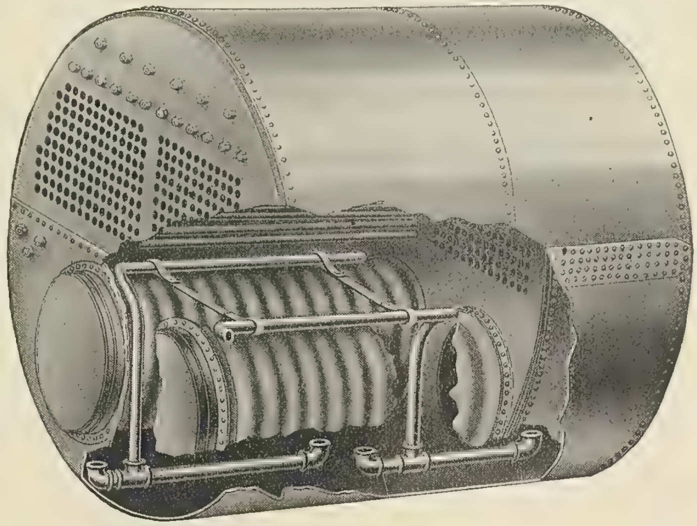


cross-sectional cuts of this cleaner, shown herewith, give a good idea as to its method of operation. As will be noted, the compressed air or steam passes through two ports in a plate in the rear end of the cleaner, then through transverse openings in the rotor, and out through branch openings to the space behind the paddles. There are only two ports opening into the air chamber, thus only the two paddles that are doing the work are under air pressure, and there is no communication to the two idle paddles, thus one of the main difficulties with other types of air-driven cleaners has been eliminated; that is, excessive leakage of air. After the air has done its work behind one of the paddles, the paddle uncovers an exhaust port, and the expanded air is allowed to pass out through the front end of the cleaner.

To permit the cleaner of operating economically under different air pressures and in different hardnesses or thickness of scale, two interchangeable rear plates are provided having different size port areas. Where there is a limited amount of air available the plate with the smaller holes can be used, thus insuring plenty of power with small amount of air. If the scale is heavy and plenty of air can be furnished the plate with larger holes can then be used and more power developed. The cleaner is furnished with either the Weinland quick repair head, or with other types manufactured by this company, and is built for cleaning tubes of 1 to 4 inches in diameter, and a special design is suitable for use in curved tubes.

Eckliff Automatic Circulator

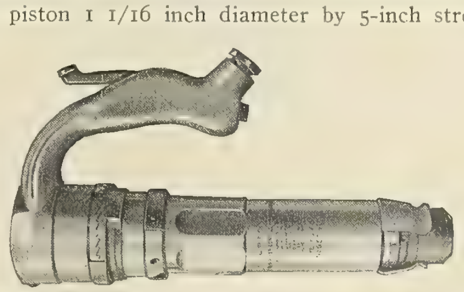
Practically the only handicap which is found in the Scotch type of boiler as a steam generator is the lack of circulation and the dead water below the grate level. To overcome this handicap the Eckliff Automatic Boiler Circulator Company, Detroit, Mich., has placed on the market a circulator which operates on the thermo-syphon principle. It is not a mechanical device but is governed entirely by the simple laws of gravitation and physics. The circulator, as shown by the illustration, consists of special tubing, so placed in the boiler that



positive heat units are absorbed from the crown sheet of the furnaces, and the circulation of the water starts as soon as a hot fire is obtained in the furnace. A blind plug, which contains a thermometer, is placed at the lowest point in the boiler, so that a glance at the thermometer will show the temperature of the water at a point in the boiler which is usually filled with dead water. With the circulator attached, however, it is claimed that a temperature of not less than 20 degrees below the temperature of the steam carried is obtained at the lowest point in the boiler, if the feed water is delivered at 125 degrees F. or better. The action of the circulator is entirely automatic; there is no wear and tear, and the only change in the ordinary construction of the Scotch boiler is to drill a single 1-inch hole in the shell to accommodate the blind plug for the thermometer.

No. 50 Boyer Hammer with Reversed Handle

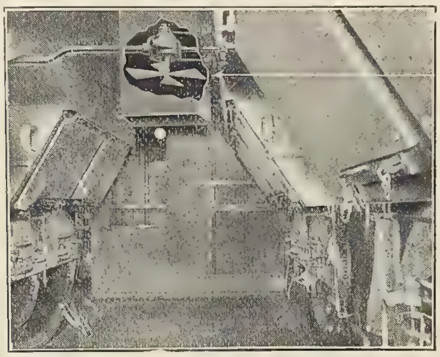
The Chicago Pneumatic Tool Company, Chicago, Ill., has placed on the market a pneumatic riveting hammer for getting into close quarters where the ordinary riveting hammer would be too long or where it could not be conveniently handled. It has a piston 1 1/16 inch diameter by 5-inch stroke; will



drive 7/8-inch rivets in structural work and 3/4-inch in steam-tight boiler work, and is 14 inches over all, including rivet set. It is particularly well adapted for driving the rivets in fire-box doors where the space is limited to about 14½ inches. In structural work this hammer is useful where the box type of girder is used.

A Practical Ventilating System

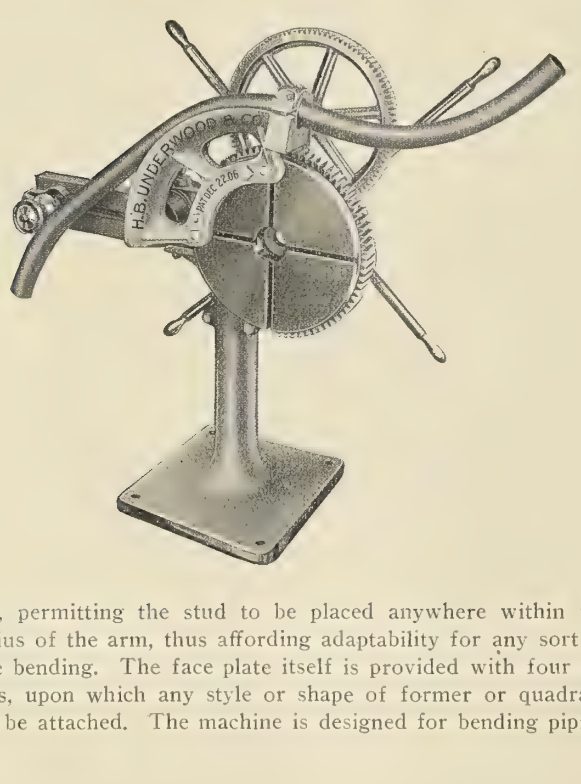
The Bryant-Bery Steam Turbine Company, Detroit, Mich., have on the market a special type of turbine designed for marine ventilating purposes. The installation can be used for the ventilation of fire rooms, engine rooms, cargo holds, galleys and living quarters. The installation is also suitable for forced draft, since it can be used either as a blower or in an exhaust system. As can be seen from the illustration, the



fan and motor form a single unit, so arranged that high temperatures do not affect its operation, permitting it to be placed directly in a stack or breeching. The construction of the turbine is such that steam is utilized, first, by impact; second, by expansion, and, third, by a patented syphon system, which, it is claimed, makes the operation of the turbine very economical. The system is furnished in various types and sizes to meet all requirements.

E and S Pipe Bending Machine

We show herewith a convenient and useful machine for bending pipes by hand which is manufactured by H. B. Underwood & Company, Eleventh and Hamilton streets, Philadelphia, Pa. The machine consists of quadrants or formers, which are mounted on a face plate which has a continuous rotary movement. A resistance stud against which the pipe rests is located on a movable arm provided with a tee



slot, permitting the stud to be placed anywhere within the radius of the arm, thus affording adaptability for any sort of pipe bending. The face plate itself is provided with four tee slots, upon which any style or shape of former or quadrant can be attached. The machine is designed for bending piping of steel, iron, brass, copper or other material up to and including 2 inches in diameter. By using special formers, light angles, flats and tee-bars can also be bent by this machine. The ratio of gearing is 25 to 1, giving a powerful leverage, so that a boy can bend 2-inch pipe. The outside dimensions of the machine, which is mounted on a telescopic stand, are: Width, 4 feet 7 inches; height, 5 feet.

The Prest-O-Welder

Welding by means of the oxy-acetylene process has firmly established itself as an important factor in the manufacture of machinery and metalware and in the reclaiming of broken castings, whether of cast iron, steel, brass, bronze or aluminum.

The Prest-O-Welder, manufactured by the Prest-O-Lite Company, Indianapolis, Ind., is a practical adaptation of this successful process to the needs of the average shop. Storage tanks of 100 cubic feet capacity are furnished for each of the gases used. This, it is claimed, eliminates the inconvenient features of the generating systems and insures safety. A supply of pure dry gas is always ready for service upon opening the valves. The whole equipment is mounted on a small steel truck, which makes the Prest-O-Welder a portable and convenient equipment for all uses. The weight of the equipment completely assembled is 300 pounds.

Welding by the oxy-acetylene process utilizes in a small, concentrated flame the heat produced by the combustion of acetylene and oxygen. The intense heat and concentration allow the recasting of the metal in the joint to be welded. As the flame is neutral the welded metal does not suffer any

injurious effects. A temperature of 6,300 degrees F. is obtained. This temperature, while more than double that required to melt any of the commercial metals, is necessary for successful welding on account of the rapid dissipation of the heat through the metal, especially where heavy material is being welded. The combustion of acetylene not only produces an extremely high temperature but also furnishes an enormous amount of heat, making possible the successful welding of the heavy materials.

The essential features of the Prest-O-Welder are an acetylene and oxygen tank, each with proper automatic reducing valves attached. The acetylene is stored in a cold-drawn, seamless steel tank, having a capacity of 100 cubic feet, and is known as dissolved acetylene, *i. e.*, acetylene dissolved in acetone in a porous filling inside the tank. The oxygen, which is to support the combustion of the acetylene, and intensify its heating power, is stored in a steel cylinder of 100 cubic feet capacity. The acetylene is led through a regulating valve, which automatically maintains a constant flow of gas. The oxygen is also controlled by a regulating valve, which can be instantly set to deliver the required amount of oxygen for the flame desired. The two gases are united in the mixing chamber of the blow-pipe. The welding heads on the blow-pipe are interchangeable and easily adapted for different sizes of material and castings.

The outfit is always ready for instant use. It needs no further attention than merely opening two valves when required. When not in use no valuable space is taken up, because the outfit is compact and easily moved about. The operation of the Prest-O-Welder is not difficult, and it is said that the ordinary workman soon becomes proficient in all its uses.

Association of Marine Draftsmen

At a recent meeting of the draftsmen of the Norfolk Navy Yard, Norfolk, Va., a permanent organization was perfected, which is to be known as the Norfolk Navy Yard Association of Marine Draftsmen. Mr. Frank H. Dewey was elected president and Mr. J. B. Sadler secretary.

This organization has for its object the promotion of the welfare of draftsmen along intellectual, social and economic lines; the establishment and maintenance of friendly relations among them in all their intercourses; the disseminating of shipbuilding and other engineering and technical knowledge; the providing of access to a wide range of technical literature; the furnishing of such records as will best serve to give the members an understanding of industrial, social and economic conditions prevailing at the various points at which draftsmen are employed, and, in general, by methods based on sound principles to develop such a standard that draftsmen, their employers and the public will cordially recognize drafting as a profession.

Similar organizations have been formed recently at a number of shipyards on the Atlantic coast, and are now being formed at the various navy yards and shipyards throughout the country, with the object in view of the formation of a National Association of Marine Draftsmen.

Personal

MR. H. C. TOWLE has been appointed chief draftsman of the merchant hull department at the New York Shipbuilding Company, Camden, N. J.

MR. THEODORE ALBERT, president of the Powell Company, died at his home in Cincinnati, Ohio, Monday, May 27.

Technical Publications

A Short Course in Graphic Statics. By William Ledyard Cathcart and J. Irvin Chaffee, A. M. Size, 5 by 7½ inches. Pages, 183. Illustrations, 58. New York, 1911: D. Van Nostrand Company. Price, $1.50 net.

Students of mechanical engineering are of necessity required to give some study to the subject of graphic statics, although the design of trusses is in general the duty of a civil engineer. Since this book is intended as a textbook for mechanical engineering students, the treatment therefore is limited mainly to the properties and general uses of the force and equilibrium polygons, a part of the subject which is usually sufficient for the solution of most of the problems which mechanical engineers are required to solve. The subject is taken up in a brief, thoroughly clear and convenient manner, and the book will prove a valuable aid to engineering students in general.

Engineering as a Vocation. By Ernest McCullough, C. E. Size, 5½ by 8 inches. Pages, 201. New York, 1911: David Williams Company. Price, $1.00 postpaid.

Nearly everyone who has devoted his life to engineering work can very easily be induced to say something on engineering as a vocation. It is not strange, however, that the average engineer would give his advice on this subject from a rather biased point of view. Opinions in this direction are probably as varied as upon any other subject of equally wide scope. There are many different branches of engineering, and each offers special advantages as a vocation, but all engineering work has this in common: that it requires certain cardinal qualities in the type of man who is capable of making a success of it. This is well set forth by the author in this book. He also proceeds to set forth some ideas about the chances for great success and the demand for engineers that are very much at variance with the commonly accepted ideas of the public. His knowledge, however, is based upon a long career of splendid achievement and cannot be accepted as far from the truth. It will well repay anyone who is contemplating taking up engineering as a vocation to read this book and inquire into the conditions which he suggests.

Marine Engineering Estimates and Costs. B. C. R. Bruce. Size, 4¾ by 7 inches. Pages, 126. Glasgow, 1911: Fraser, Asher & Company, Ltd. Price 4s. 6d.

No engineer can be considered to have mastered his profession until he has become thoroughly familiar with its commercial side. In such large establishments as shipyards the technical and commercial departments are always separated by a more or less hard-and-fast line, and sometimes both the technical man and the commercial man come to sword's points. Where the commercial end of the work is placed entirely in the hands of a department which is separated from the technical or engineering work, there are apt to be misunderstandings, and much better harmony can be obtained in the management of such an establishment if each department becomes more familiar with the work of the other. The point where these two departments have most in common is in the making up of estimates for new work and the cost accounting of machinery passing through the shops. The author of this book, therefore, has undertaken a most useful task in setting forth rather briefly the general principles under which such work is done. The book is not an explanation of the practice of any one concern, but is applicable to almost any shipyard or engine works. First are considered the inquiry and specification; then the agreement or contract; the division of work between machinery and hull, and a standard estimate. For this some very valuable information is given on estimating weights and labor charges for the construction of engines and boilers, also the computation of establishment charges. A chapter is devoted to the determining of approximate machinery sizes, and several chapters to different cost

accounting system. Finally, a chapter is devoted to the relative costs of different types of marine propelling machinery and the trend of development in marine propulsion. The book has every reason for commendation, and it is only to be regretted that the work was not carried on further.

Maximum Production in Machine Shop and Foundry. By C. E. Knoeppel. Size, 5 by 7½ inches. Pages, 365. Illustrations, 34. New York, 1911: *The Engineering Magazine.* Price, $2.

Most of the subject matter presented in this book is based on three series of articles published recently in *The Engineering Magazine.* When the matter was arranged in book form, however, it was largely recast and rearranged in order to present the subject in a well balanced and well proportioned form from beginning to end. The author of the book is a man whose work has been intimately connected with current practice on the foundry floor and in the machine shop, so that he is thoroughly familiar with shop conditions and workmen. He has, further, been under the influence of and received training from one of the foremost efficiency engineers, so that the book was shaped by very wide experience and sound judgment. The machine shop and foundry are considered as twin factors in production, one of which is as important as the other, and, since they are so closely related, many of the principles of organization and management tending to efficient operation and maximum success are common to both. The differences in the two are carefully brought out, and the whole gives a valuable insight into what is probably the most important modern metal industry.

Marine and Naval Boilers. By Lieut.-Com. Frank Lyon, U. S. N., and Lieut.-Com. A. W. Hinds, U. S. N. Size, 5¾ by 9¼ inches. Pages, 450. Illustrations, 112. Annapolis, Md., 1912. United States Naval Institute. Price, $3.50 postpaid.

Designed as a textbook for use at the United States Naval Academy, this book has been based upon a previous text-book on steam boilers by Capt. F. C. Bieg, U. S. N., which has been used at the Academy since 1903. Recent advances in boiler construction and management, however, required a new treatment of the subject, and, owing to the death of Capt. Bieg, the work of revising the former textbook was undertaken by the authors of the present volume. Unlike most standard textbooks on steam boilers, very little consideration is given to the subject of boiler design, calculation of strength and methods of manufacture. A great deal of attention is given, however, to the description of details of various types of watertube boilers, which are commonly used in naval vessels, together with most of the boiler accessories. The subjects of heat and heat transfer, combustion, fuel and firing of boilers are carefully considered, and the parts given to liquid fuel and methods of firing liquid fuel are of particular value to naval men, since oil-fired boilers are becoming more general in naval service every year. Most of the descriptive matter is supplemented by excellent illustrations, which are reproduced on a large scale from detail drawings.

Practical Thermodynamics. By Prof. Forrest E. Cardullo, M. E. Size, 6 by 9 inches. Pages, 411. Illustrations, 224. New York, 1911: McGraw-Hill Book Company. Price, $3.50 net.

The author of this book has presented the subject of thermodynamics from the physical rather than from the mathematical standpoint, so that common sense rather than a knowledge of higher mathematics is the guide for the reader. Thermodynamics is always looked upon by students in technical schools as a very difficult subject, because the principles are hard to understand at first sight, and the whole work is usually wrapped up in such extensive mathematical details, expressed in new forms of phraseology, that the main points are somewhat obscure. In this work, however, the subject is taken up in a manner somewhat different from the usual textbook. In the first place, it is as simple as it would seem possible to make such a work, and then the order in which the points are made lead the reader to grasp the principles and understand the phenomena of heat engines and other thermodynamic machinery in their proper sequence. The fundamental physical principles upon which further study of the subject must depend are given in the first seven chapters. Then follow the application of these principles to the various types of engines and machinery. Each chapter is followed by a number of carefully chosen problems, the solution of which is useful in suggesting the application of principles rather than for bringing out the student's knowledge of the subject matter in the chapter. The book is a valuable addition to the field of practical engineering literature.

Lloyd's Register of American Yachts, 1912. Edited by W. P. Stephens. Size, 9 by 7 inches. Pages, 502. 46 illustrated plates. New York, 1912: Lloyd's Register of Shipping. Price, blue cloth, gilt edges, $8.50; plain canvas, $7.00

Lloyd's Register of American Yachts may now be considered a permanent institution in yachting, having reached its tenth volume and attained a size proportionate to the great growth of the sport since the general adoption of the marine gas engine. Replacing the older registers once known to sailing yachtsmen, the book follows the same general lines, but differs in the far larger number of power craft and the extra detail required for their proper description.

The total number of yachts registered this year is 3,533, about 60 percent of these being in the power division of the fleet; large steam yachts, auxiliaries, small and large, and gasoline (petrol) cruisers of all sizes; the relative decrease of the sailing yacht being more rapid each year. The changes from last year are, for the most part, made up of the dropping of a number of the older sailing yachts, both small and large, and the addition of several sizes of gasoline (petrol) cruisers, notably the handy and convenient little raised-deck launch of 28 to 35 feet length, and the cruiser of 75 to 100 feet. The additions to the sailing division of the fleet are comparatively unimportant, and the conversion of sailing yachts to auxiliaries which went on so rapidly several years ago is less marked, for the reason that most of the outclassed sailing yachts have been already converted, and the older ones, dating from the early Burgess era, about 1885, are being sold for fishing or for breaking up.

One of the favorable signs of yachting is the steady growth in popularity of the cruising launch, largely of the raised-deck type, in all parts of the country; the users of these craft being recruited alike from the ranks of the old sailing yachtsmen and from the newcomers in yachting. This class of yacht is rapidly outnumbering all others in the old yachting centers of the Atlantic coast; it is making new converts to yachting on the Western lakes and rivers; it is represented in larger numbers each year in Florida and other Southern waters; while Puget Sound can boast of a large fleet of very fine cruisers, nearly all of recent construction.

The burgees of these clubs, to the number of nearly 500, make up thirteen handsome color plates, and two more plates are devoted to the National ensigns, the International Signal Code and the Weather Bureau signals. The private signals of yachtsmen, to the number of nearly 2,000, are also given in colors, while the list of owners contains the names and addresses, to the number of 3,350, of the owners of all yachts entered in the Register with the clubs of which he is a member, the yachts he owns and the number of his private signal. One important feature of the Register which has been considerably extended this year is the American Trade Directory, a complete list of all the arts and industries connected with yachting, forming a guide for the yachtsman in the purchase of every class of yachting requisite.

Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

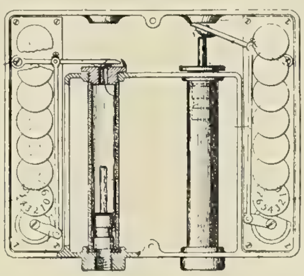
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,010,568. FLOAT FOR DREDGES. HARRY J. BARNHART AND HARVEY T. GRACELY, OF MARION, OHIO, ASSIGNORS TO THE MARION STEAM SHOVEL COMPANY, OF MARION, OHIO, A CORPORATION OF OHIO.

Claim 1.—In a dredge the combination, with a hull and a float, of a brace loosely connected to said hull and normally movable relatively thereto, said brace being disconnected from said float and arranged to extend over the latter to retain the same in position and adapted to be moved away from the float to permit the float to be removed. Six claims.

1,010,662. REGISTERING AND INDICATING APPARATUS. ALEXANDER McNAB, OF NEW LONDON, CONN., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE McNAB COMPANY, OF BRIDGEPORT, CONN., A CORPORATION OF CONNECTICUT.

Claim 1.—An apparatus for indicating and registering the number of revolutions of a shaft, comprising an air tight casing, an agitator driven positively with a motor, indicator tubes wiithin said casing and communicating therewith, freely movable plungers within said tubes and having pin extensions, registering mechanisms compising a train of



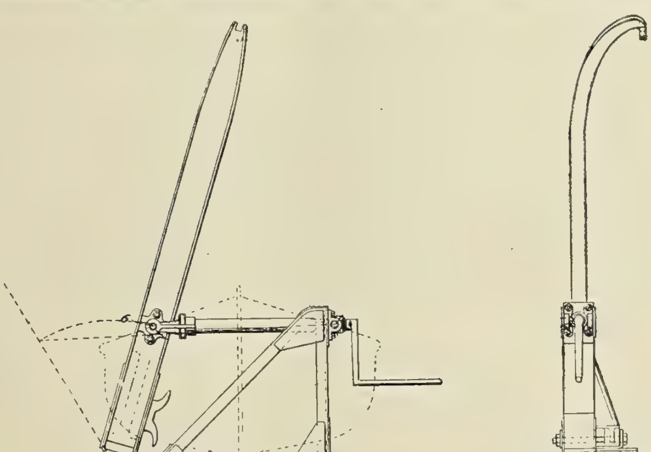
sequentially connected counters, levers pivoted within said casing and normally within the path of said extensions, and operative connections between said levers and registering mechanisms whereby the impacts and withdrawals of said extensions will throw said levers and allow them to return to normal positions and thereby effect the operation of said registering mechanisms. One claim.

1,010,767. LOADING AND TRIMMING MECHANISM FOR BOATS. GEORGE H. HULETT, OF CLEVELAND, OHIO, ASSIGNOR TO THE WELLMAN-SEAVER-MORGAN COMPANY, OF CLEVELAND, OHIO.

Claim 1.—In a machine the combination with a depending tubular member and a laterally projecting chute at the lower end thereof, of a tilting housing pivotally supported by said depending member and supporting said chute. Twenty claims.

1,011,477. BOAT-DAVIT. HAROLD F. NORTON, OF NEWPORT NEWS, VA.

Claim 1.—A davit supported by a pivot at its lower end, and means for oscillating said davit, comprising two substantially horizontal members connected by a nut and long screw, one member being non-revoluble



and directly swiveled to said davit intermediate its ends, the other member being revoluble, and a fixed deck-stool having a swiveled bearing in which said revoluble member is journaled, its outer end extending through the bearing and carrying a crank. Three claims.

1,013,024. METHOD OF AND APPARATUS FOR CONSTRUCTING HULLS OF VESSELS. SIMON LAKE, OF MILFORD, CONN.

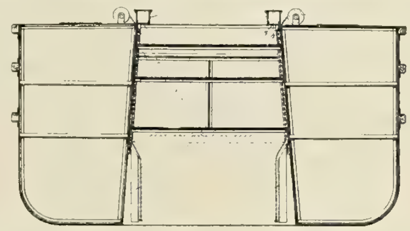
Claim 1.—The method of constructing hulls of vessels, which consists in properly locating the ribs of the hull, then arranging a portion of the plates forming the skin of the hull in position over the ribs and welding them to said ribs and end to end to each other throughout practically the entire length of the hull, and finally arranging the remaining plates in position and welding them to said ribs and welding their abutting ends to each other and their longitudinal edges to the abutting edges of the plates first welded in position. Six claims.

1,018,050. SUBAQUEOUS ROCK-BREAKER. ALEXANDER W. HASSELL, OF JERSEY CITY, N. J., ASSIGNOR, BY MESNE ASSIGNMENTS, OF ONE-HALF TO HASL-COE CONSTRUCTION COMPANY, A CORPORATION OF NEW YORK.

Claim 3.—In a device of the class described in combination, lifting means, a crusher bar, and a gripping device; said gripping device including means for engaging the crusher bar, and means for automatically disengaging the crusher bar from the gripping device when the crusher bar is raised to a predetermined point; and means for limiting the downward movement of the gripping device. Seven claims.

1,018,565. SCOW FOR TRANSPORTING GRAVEL AND THE LIKE. THOMAS C. JACKSON, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-THIRD TO ROSE J. A. SHANKS, OF CHICAGO, ILLINOIS.

Claim 2.—A scow having a compartment which is open at its top and at its bottom, a plurality of superposed supporting and separating



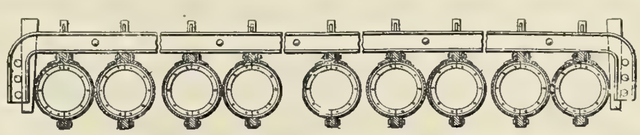
screens for material extending across the compartment and supported on the side walls thereof, the mesh of the upper screen being larger than the mesh of the lower screen. Fourten claims.

1,018,848. CLAM-SHELL DREDGER. SAMUEL CHARLES SMITH, OF DAISY, LOUISIANA.

Claim 1.—In combination, a frame, a rotatable nut vertically mounted in the frame and provided with a beveled gear at one end and having its other end held against movement upwardly and downwardly, a vertical screw extending through said nut and having threaded engagement therewith, shafts supported in the frame at right angles to said screw, drums on said shafts each provided with a beveled gear meshing with the gear carried by the nut, oppositely wound suspended cables respectively attached to said drums, scoops pivotally attached to the lower end of said screw and means for pivotally suspending them from the frame. One claim.

1,019,224. RAFT FOR DREDGES. HORACE J. CLARK, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE CLARK DREDGE MANUFACTURING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF MAINE.

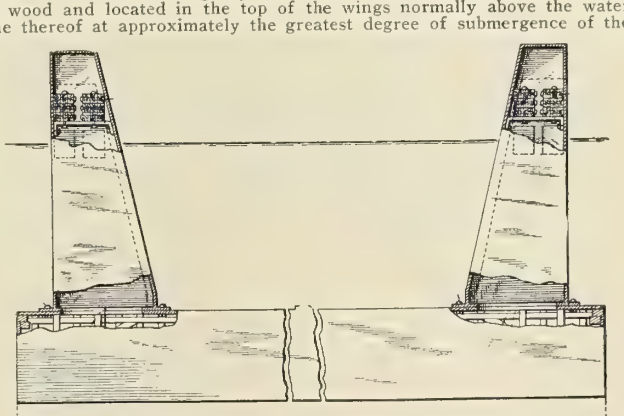
Claim 1.—A raft of the kind described comprising a plurality of floats, each float being formed of a plurality of sections bolted together, beams



carrying means for holding said floats in their proper relation, and straps and keys for connecting said floats to said beams. Eighteen claims.

1,019,434. FLOATING DRY-DOCK. WILLIAM THOMAS DONELLY, OF BROOKLYN, N. Y.

Claim 1.—In a floating dry dock, heavy solid buoyant means formed of wood and located in the top of the wings normally above the water line thereof at approximately the greatest degree of submergence of the



dock, when under control and thereby normally acting as ballast and adapted, when control of the dock is lost, to be thereby automatically submerged and caused to act as buoyancy and prevent the dock from being entirely submerged. Two claims.

1,019,437. SCREW-PROPELLER. CLARE H. DRAPER, OF HOPEDALE, MASSACHUSETTS, ASSIGNOR TO C. F. ROPER, COMPANY, OF HOPEDALE, MASSACHUSETTS, A FIRM.

Claim 2.—A propeller blade whose working surface has generating lines

increasing in curvature from the leading to the following edge, said generating lines being tangent to radii at the periphery of the hub and forward of such radii throughout their length. Three claims.

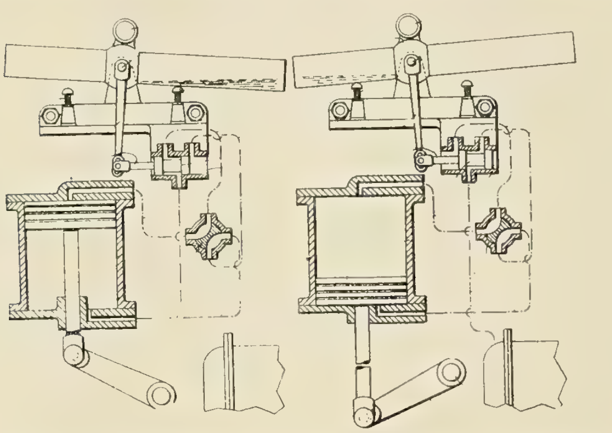
1,019,226. HATCH-FASTENER. WILLIAM CRAIGIE, OF GODERICH, ONTARIO, CANADA, ASSIGNOR OF ONE-SIXTH TO WILLIAM MARLTON AND ONE-SIXTH TO WILLIAM WALLACE, BOTH OF GODERICH, CANADA.

Claim 1.—The combination with the hatch cover, coaming and tarpaulin, of a bracket arm secured to the coaming, a hook-shaped clamp pivoted to one side of the bracket arm having a suitable upper end designed to hook over the edge of the hatch cover, a cam having a suitable recess therein to receive the end of an operating lever, said cam being pivoted to the bracket arm and engaging the hook-shaped clamp, a batten for holding the canvas in place and a supplemental cam pivoted to the opposite side of the bracket arm to the aforesaid cam and engaging the batten, said supplemental cam having a recess therein to receive the end of the operating lever. One claim.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

29,078. MARINE ENGINE GOVERNORS. T. JACKSON, NEW CROSS, AND A. RAMSAY, FOLKESTONE.

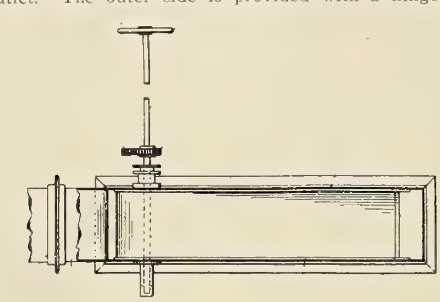
This invention relates to governors in which a gravity controlled device is utilized to control the operation of mechanism for actuating the throttle valve. The first figure shows the instrument adjusted for head seas, the head of the ship being to the left. When the vessel pitches



the mercury in the tube flows to the left suddenly and the tube rests on the other stop, as in the second figure. Air can then enter through governor valve and reversing valve to the top of the cylinder, the piston of which operates the throttle. Simultaneously the lower end of the cylinder is opened to the vacuum of the condenser.

18,633. SHIPSIDE SEA WATER VALVE OR INTAKE. J. HALLIDAY, LIVERPOOL.

By this invention the intake of water is automatically effected when the valve is opened. A casing is bolted over an orifice cut in the forward part of the ship's side, on the flat back from the bow, and has a rearward outlet. The outer side is provided with a hinged door, the



hinge at the rear, the door opening outwardly from the ship's side and closing flush with it. The spindle of the hinge by which the door is controlled when operated by hand, has a geared sector engaging a spur wheel carried by an operating shaft fitted with a hand wheel. In this way a rapid supply of water may be obtained for any purpose.

135. PROPULSION OF SHIPS AND THE LIKE. F. JENSEN, COPENHAGEN.

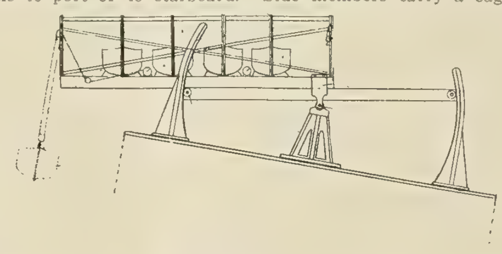
By this method the ship is propelled and steered by suction and pressure devices, the distinguishing feature being that the suction pipes, which are directed towards the fore part of the ship, emerge through the stern-half of the ship's bottom and the pressure pipes, which are directed towards the stern, emerge through the fore-half of the ship's bottom, and are so arranged that the position of the ship in relation to the horizontal and in part also the speed of the ship are thereby determined.

13,349. SHIP PROPELLER. GEORG ARTHUR SCHLOTTER, OF DRESDEN, GERMANY, ASSIGNOR TO SCHLOTTER-PROPELLER-PATENTVERWERTUNGS-GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, OF DRESDEN, GERMANY.

Claim 1.—A propeller comprising helicoidal blades the surface of which is formed by the movement of a generatrix composed of a straight line of constant length whose end-points move on an outer and inner cylinder concentric with the axis of the propeller, said generatrix being tangential with the inner cylinder and forming with a radius drawn from its outer end-point to the propeller axis an angle which is equal to the angle of pitch of the blades. Five claims.

18,402. STOWING AND LOWERING AND RAISING SHIPS' BOATS. W. J. GREENFIELD, WATERFORD.

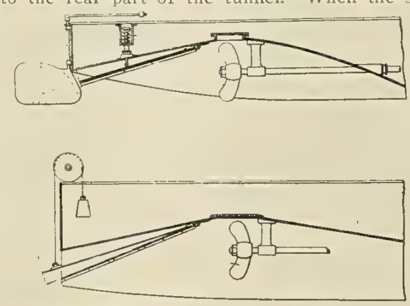
Claim.—The apparatus comprises a platform provided with a railway and placed athwartship on the ship's deck and free to be rocked on trunnions to port or to starboard. Side members carry a cage having



rails and trolleys from which the boats are suspended, and the side members and cage of boats can be caused to travel to port or to starboard on the platform so that the boats may be raised or lowered by tackle.

28,726. PROPELLER CHAMBERS OR TUNNELS FOR SHALLOW-DRAFT VESSELS. A. F. YARROW, BLANFIELD, N. B.

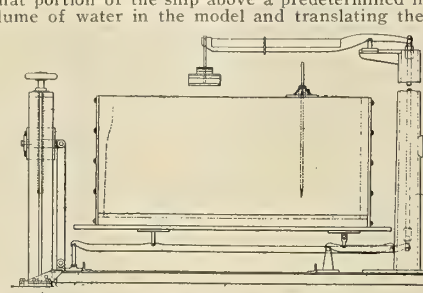
Claim.—Shallow-draft vessels when propelled by screws mounted in tunnels above the water level are provided with a flap adapted to form a false roof to the rear part of the tunnel. When the ship is at rest



these flaps rest upon air-tight ledges. In running forward the expelled water raises the flap, which is balanced by a spring or weight, so that no power is wasted in forcing the water below the level. In going astern the flap remains on its ledges and prevents access of air to allow the fall of the water level.

15,832. MEANS FOR ASCERTAINING THE WEIGHT OF A SHIP AT ANY TIME WHEN AFLOAT. W. H. WILLIAMS, R. I. M. S. "NORTHBROOK."

Claim.—This invention consists in the use of a measuring shell model, so constructed that it may be filed with some of the water in which the ship floats and whose volume will be in proportion to the volume displaced by that portion of the ship above a predetermined line. By weighing the volume of water in the model and translating the weight of the



representative water into actual weight of displacement the weight of the ship is ascertained. A proportionate mould of the exterior of the ship between horizontal planes at or near the light and deep load lines respectively is used and means for indicating the immersion above the lower plane. The shell model stands on a weighing platform, so that on filling the shell with water to a depth shown by a gage to correspond with the actual immersion of the vessel beyond the lower plane the weight of water actually displaced by the portion of the ship above this plane can be ascertained. This weighing machine is carried on a platform that can be leveled fore and aft and 'thwartship, and the platform fixed so that the axes of the shell and ship are parallel.

26,134. SHIP'S SOUNDING APPARATUS. A. I. GARCIA, NAVAL CAPTAIN, LONDON. (A COMMUNICATION FROM J. I. GARCIA, NAVY OFFICER, BUENOS AIRES.)

Claim—This is an apparatus in which a feeler bar is mounted so that it may turn horizontally and vertically near the center of the keel with which it is held normally parallel by a chain wound on a drum. When in use the bar is lowered until it makes an angle of 55 degress with the keel. Should the ship run over ground less than 30 feet below the surface the bar is raised and allows a light rod to rise correspondingly and indicate on a scale the depth of water below the keel. A sliding contact rests above the rod and may be set for any depth indicated by the bar, so that when the rod touches the contact an electric alarm is rung.

International Marine Engineering

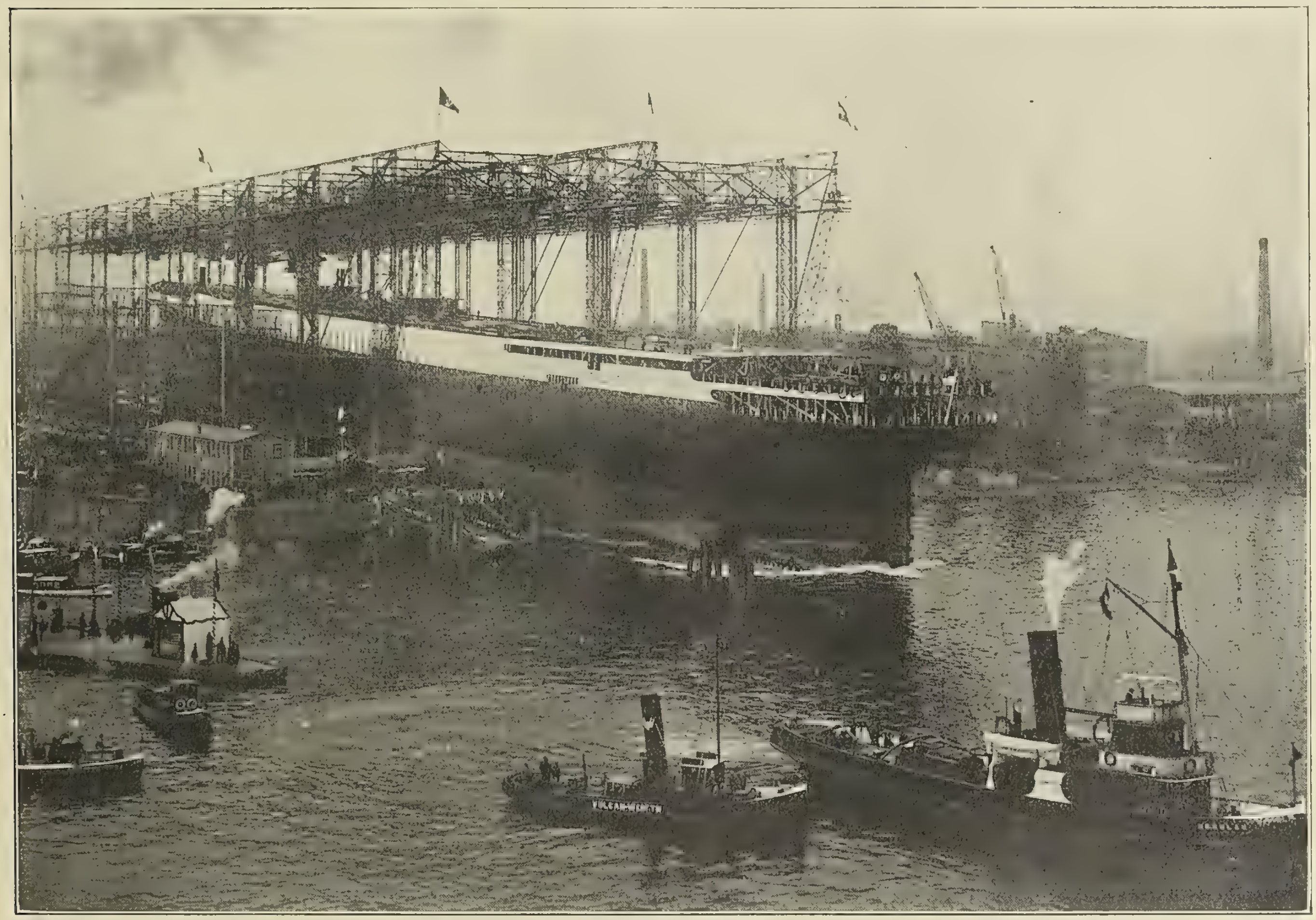
AUGUST, 1912

The Hamburg-American Company's New 50,000-Ton Liner

Although the construction of the Hamburg-American liner *Imperator* was begun at the Vulcan Shipbuilding Works, Hamburg, over two years ago, very little information was made public at that time regarding the details of this magnificent steamship. She was known as the biggest ship then projected, and the natural inference has been that she would be designed to provide every modern device for safety, comfort and luxury, as has been the aim in the company's previous vessels. At the time of the launching of the vessel in May last, when she was christened by the Kaiser, many of the important details regarding the construction and equipment of the vessel were made known, and we are indebted to the owners for the following particulars:

The length of the vessel is 900 feet, the beam 96 feet and the depth 62 feet. The boat deck is 100 feet from the keel, and the trucks of the masts rise to a height of 246 feet above the keel. Three funnels are installed, each 69 feet long of oval shape, measuring 29 feet by 18 feet.

The hull is fitted with a cellular double bottom extending for nearly the whole length of the vessel. The dimensions of the tank itself are 767 feet 6 inches length, 85 feet width, 6 feet depth, giving a cubic capacity of 291,000 gallons. The hull is divided into watertight compartments by both transverse and longitudinal bulkheads. There are twelve transverse bulkheads, those amidships extending from the double bottom to a height of 50 feet, or for a distance well above the waterline. Towards the bow, the bulkheads run up to a greater height, and the forward collision bulkhead extends to the first deck. Longitudinal bulkheads are fitted in the boiler space to form wing bunkers, and also in the forward engine room, where the wing compartments are used for auxiliaries. In the after engine room there is a single longitudinal bulkhead on the center line of the ship, the cargo holds, both forward and aft, of course, extending across the full width of the ship. In the bulkheads there are in all thirty-six watertight doors, which are fitted with an automatic closing system



LAUNCH OF THE IMPERATOR

operated by the use of electric and pneumatic power, enabling complete control of all the doors from the navigating bridge, or the doors may be controlled individually at their separate locations.

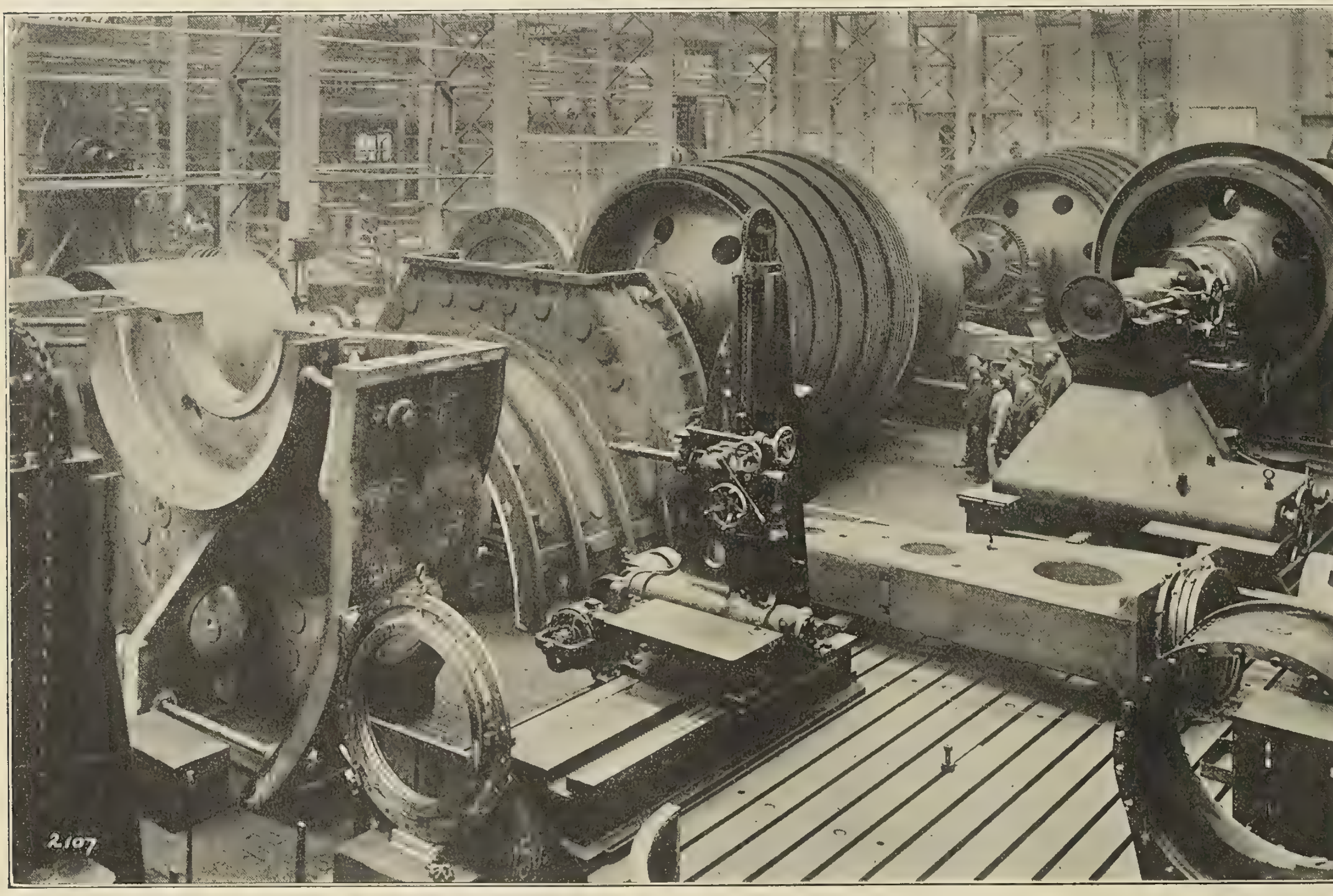
Only a general statement has as yet been made regarding the machinery arrangement of the vessel. The main engines are Parsons turbines of 70,000 horsepower, operating four propellers, which are designed to give the ship a speed of 22½ knots. The propeller shafts are 18 inches diameter, with four-bladed propellers of Turbadium bronze, 16 feet 5 inches diameter. Some idea of the size of the turbines can be gained from the illustrations and from the fact that the low-pressure rotors weigh 135 tons. The outer casing inclosing these rotors is 25 feet long and 18 feet wide.

The arrangement of passenger accommodations in the *Imperator* are in keeping with the modern tendency to eliminate the cramped quarters which were formerly found on shipboard. The size of staterooms and of public saloons has been increased. In the first class staterooms the old-time built-in berths have been replaced by metal bedsteads, and a large number of single-berth rooms have been provided. Similar arrangements have been made in the second class accommodations, and the whole arrangement will very strongly resemble the accommodations to be found in first class hotels on shore. All the rooms will be provided with electric connections for lighting, heating, ventilation, call bells, etc. Supplementary to the steam heating system electric heaters will be provided, and a complete artificial ventilating system is installed which provides for excellent air circulation according to the requirements of each room. Besides the large main stairways between decks, electric elevators provide communication through five decks. The Ritz-Carlton and Veranda café features, which were brought out on the Hamburg-American steamers *America* and *Kaiserin Auguste Victoria,* will be found on the *Imperator*. Besides this there will be a ball room for concerts, entertainments, dances, etc., a very complete gymnasium and small shops to meet the needs of the passengers.

A large amount of deck space in first-cabin quarters is set aside for promenade decks. The upper promenade deck is inclosed at the front and along two-thirds of the length on each side by heavy plate-glass windows for protection in stormy weather.

Anti-rolling tanks, built according to the Frahm system, are installed to reduce the rolling of the ship. Lifeboats and liferafts will be provided sufficient to accommodate all on board. A gyroscopic compass will be used, and the ship will be fitted with submarine signals and a powerful wireless outfit.

Electric current for lights and power purposes on board the ship are provided by five turbo-generators of 2,000 amperes and 110 volts. An additional generator of 100 amperes capacity is placed above the waterline to provide current for lighting in case the main electric plant is disabled by flooding of the dynamo compartment. It is expected that all minor repairs will be carried out on board the ship, for which purpose a completely fitted machine shop has been located in the forward engine room, the equipment consisting of lathes, drills, planers and a full equipment of small tools.



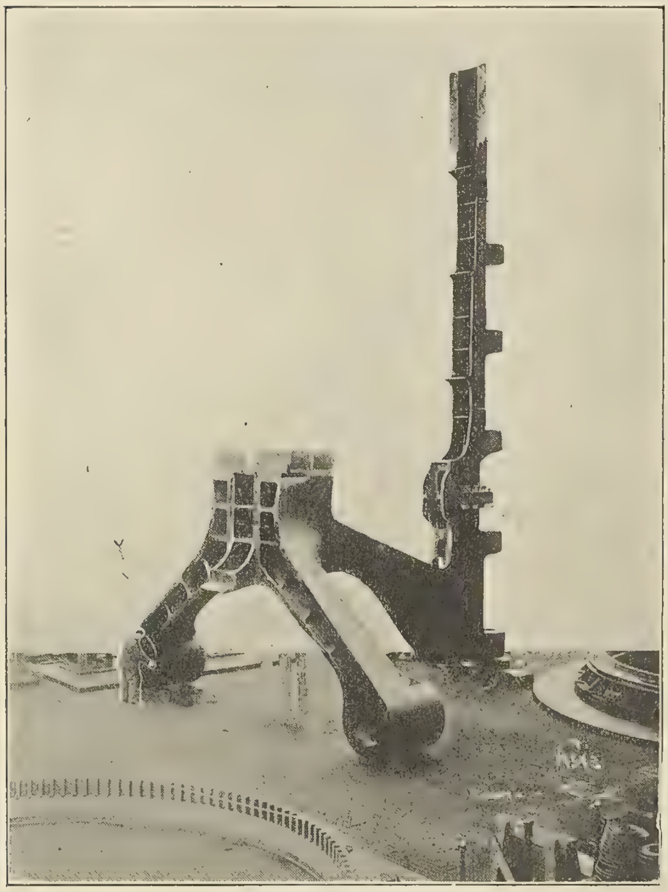
IMPERATOR'S TURBINES UNDER CONSTRUCTION IN THE VULCAN SHOPS

The steam fire-fighting apparatus is of the latest and most approved type. In addition, hand extinguishers are conveniently placed throughout the ship. Powerful pumps will always be ready for immediate use. As a special protection against fire a number of smoke bulkheads have been constructed in the passenger decks.

Not only will every practical mechanical device be installed, but every possible facility for their use by the crew has been

THE IMPERATOR AS THE VESSEL WILL APPEAR WHEN COMPLETED

provided for. Station bells, locating the number and position of each man on board, from the captain down to the last trimmer, no matter what the occasion or stress, will assemble the crew into a completely organized force, able to control any situation. Frequent drills will enable familiarity and breed confidence in this most valuable human factor. Fire and boat drills will be held frequently. At night, and during fog, all watertight doors will be closed. The living quarters of the officers and crew are so arranged and placed that each



RUDDER POST OF THE IMPERATOR

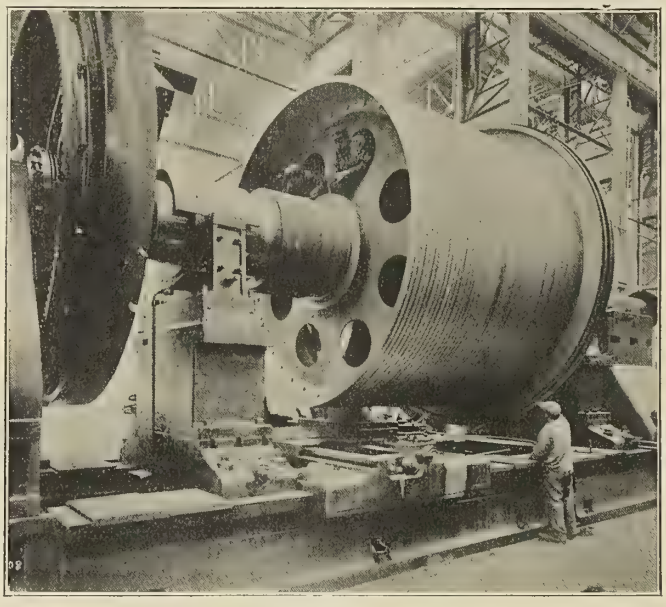
man will be near to his work, so that even in off-duty periods prompt response to all calls can be made.

The question has been raised whether the development of such gigantic structures is justified by the needs of the world's commercial requirements and not merely to justify their projector's desire to excel and to have an advantage over competitors. Certain it is that the safety of ocean travel is not diminished by the construction of ships of large dimensions, but, on the contrary, it is greatly increased. Professor Pagel, of the Germanic Lloyd, states that safety of travel at sea increases with the size of the ships. He demonstrates in detail why the stability and reserve buoyancy of the large ship exceed those of the smaller vessel. The ability of the large ship to withstand the effects of sea and wind is well known. The extreme steadiness of the large ship, even in a rough sea, has been looked upon as a boon by those passengers susceptible to seasickness. But the most vital consideration in reference to construction, materials and methods of insuring safety, as laid down by the highest authorities, such as the Germanic Lloyd's, the immigration authorities and other bodies, is as thoroughly and conscientiously applied in the large vessel as in her small sisters, with the additional advantage that in the larger vessel these measures for safety can be carried out in a stronger and even more satisfactory way.

Relation of Units Horsepower and Kilowatt*

There was, before 1911, no precise definition of the horsepower that was generally accepted and authoritative, and different equivalents of this unit in watts are given by various books. The most frequently used equivalent in watts, both in the United States and England, has been the round number, 746 watts, and in 1911 the American Institute of Electrical Engineers adopted this as the exact value of the horsepower. It is obviously desirable that a unit of power should not vary from place to place, and the horsepower thus defined as a fixed number of watts does indeed represent the same rate of work at all places. Inasmuch as the "pound" weight, as a unit of force, varies in values as *g*, the acceleration of gravity, varies, the number of foot-pounds per second in a horsepower accordingly varies with the latitude and altitude. It is equal to 550 foot-pounds per second at 50 degrees latitude and sea level, approximately the location of London, where the original experiments were made by James Watt to determine the magnitude of the horsepower.

The "Continental horsepower," which is used on the continent of Europe, differs from the English and American horsepower by more than 1 percent, its usual equivalent in watts being 736. This difference is historically due to the confusion existing in weights and measures about a hundred years ago. After the metric system had come into use in Europe the various values of the horsepower in terms of local feet and pounds were reduced to metric units, and were rounded off to 75 kilogram-meters per second, although the original English value was equivalent to 76.041 kilogram-meters per second. Since a unit of power should represent the same rate of work at all places, the "Continental horsepower" is best defined as 736 watts; this is equivalent to 75 kilogram-meters per second at latitude 52 degrees 30 minutes, or Berlin. The circular gives tables showing the variations with latitude and altitude of the number of foot-pounds per second and of kilogram-meters per second in the two different horsepowers.



ONE OF THE IMPERATOR'S LOW-PRESSURE ROTORS

These values, 746 and 736 watts, were adopted as early as 1873 by a committee of the British Association for the Advancement of Science. The value, 0.746 kilowatt, will be used in future publications of the Bureau of Standards as the exact equivalent of the English and American horsepower.

*Abstract of Circular of the Bureau of Standards No. 34, Washington, D. C., June 1, 1912.

It is recognized, however, that modern engineering practice is constantly tending away from the horsepower and toward the kilowatt. The Bureau of Standards of the Department of Commerce and Labor and the Standards Committee of the American Institute of Electrical Engineers recommend the kilowatt for use generally instead of the horsepower as the unit of power.

Marine Engineering Development

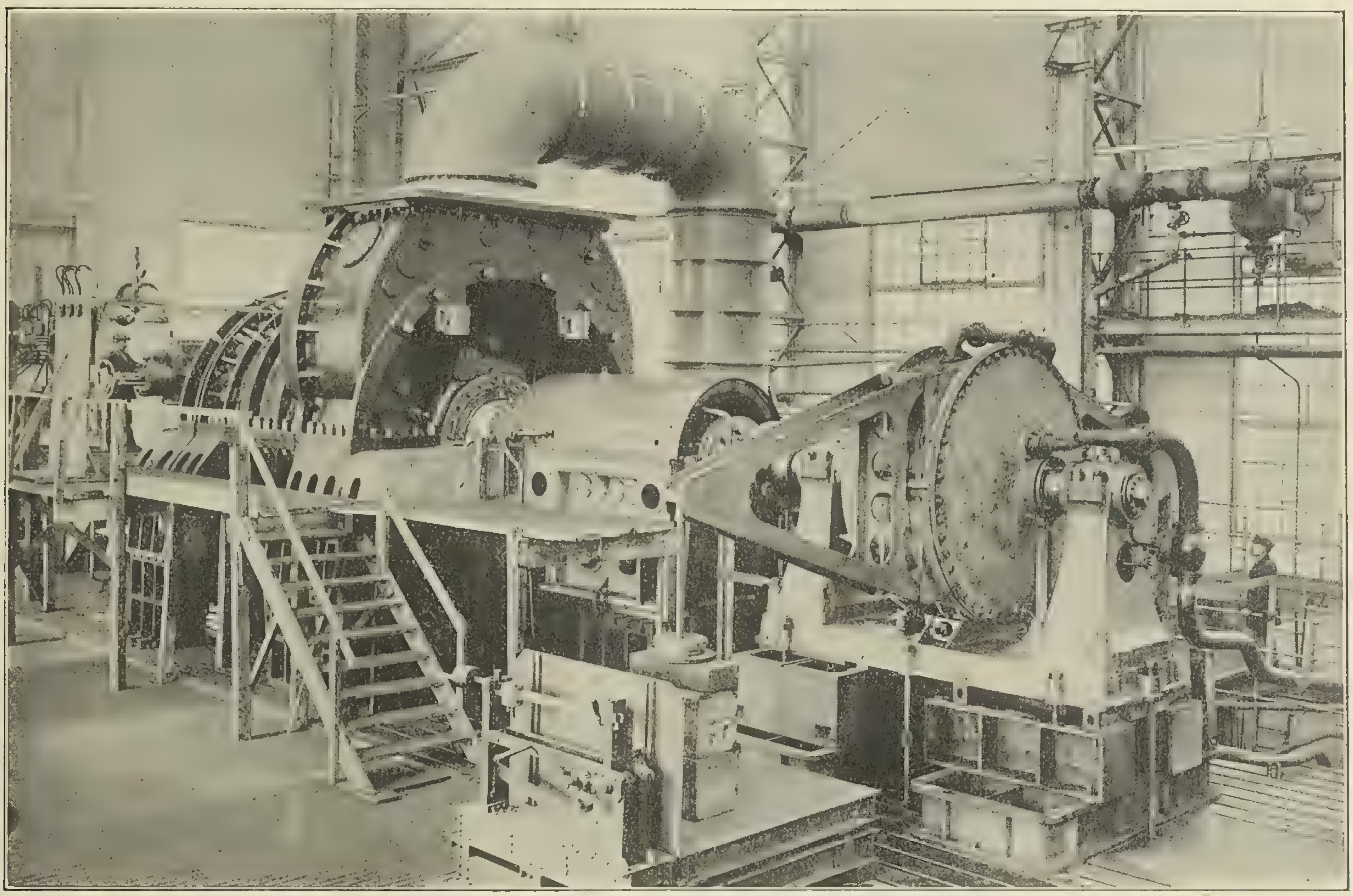
Probably never before in the history of engineering have so many and diverse proposals been engaging the serious study of experts for increasing efficiency and economy in marine engineering, and that the problem of ship propulsion is on the eve of great devolpments seems certain. In the recently-issued International Number of *The Shipbuilder* some of the greatest living British and foreign experts have been expressing their views, and these are briefly summarized below.

Dr. Rudolf Diesel, the eminent German scientist and engineer, whose name will always be associated with the internal-combustion engine, writes: "With regard to marine engines, it is unquestionable that one of the greatest evolutions of modern industry will be connected with the development of the Diesel oil engine, and Great Britain, as the greatest shipping nation of the world, will derive the greatest advantage from it."

Mr. D. M. Shannon, a well-known British expert, looks still further than his German contemporary, and remarks: "Oil-engine workers recognize that the piston engine is only a temporary solution of the problem of internal-combustion engines, and that a reversion to the turbine principle will be the natural outcome of the inherent limitations and disadvantages of the reciprocating form of motor."

Advocating another form of internal-combustion engine, Mr. A. C. Holzapfel, who has devoted much labor and money to the solution of the problem, writes: "The suction gas engine and plant in their present form are capable of vast improvement as regards marine work, but the possibilities of this type of prime mover are such as to deserve the careful consideration of all marine engineers."

Mr. E. Hall-Brown, the president of the Institution of Engineers and Shipbuilders in Scotland, has great faith in the marine steam engine, for he writes: "The author is a firm believer in the future of the internal-combustion engine, both on sea and land. He is not, however, convinced that the final development will be along the present lines. As regards reliability, ease in adjustment and simplicity in manipulation, the marine steam engine is yet without a rival. If to these advantages be added increased economy, such as he believes possible of attainment, it is doubtful if any internal-combustion engine yet proposed will take its place in ordinary merchant vessels."



TESTING ONE OF THE IMPERATOR'S TURBINES AT THE BUILDER'S WORKS

Sir Charles A. Parsons, the inventor of the marine steam turbine bearing his name, advocates the claims of the geared turbine, remarking: "Apart from the adoption of superheated steam or the burning of oil fuel in the boilers from which further advantages would be secured, the author estimates that the saving of 15 percent in coal consumption, which can be effected by the adoption of geared turbines instead of reciprocating engines, means, in the case of a cargo steamer carrying 8,500 tons deadweight and steaming 10½ knots on service, a gain to the shipowner in the neighborhood of $9,740 (£2,000) per annum."

Finally, Mr. Harold E. Yarrow, the brilliant young Clyde shipbuilder and engineer, draws attention to the improvement in economy of from 8 to 10 percent when using 100 degrees F. of superheat, and from 11 to 13 percent when using 150 degrees F. of superheat.

Liquid Fuel Measurement on Oil-Burning Steamships—I

BY HOWARD C. TOWLE

The rapidly increasing use of liquid fuel in naval, merchant and pleasure vessels calls attention to the possibility of the owner and the engineer knowing, with considerable accuracy, the fuel consumption of such vessels, without the trouble and errors that persistently appear in ordinary service measurements of fuel economy in coal-burning power installations. The difficulty of obtaining accurate results, and the expense for the necessary additional labor and superintendence in the fireroom, when making coal-burnings tests, are such that the majority of owners are of necessity contented with figures for fuel economy deduced from more or less exact guesses made by the engineer at the amount of coal consumed and the power developed. It is unfortunately true that these approximations are made in many cases with prejudice, since it is realized that the total consumption that is reported must be in reasonable agreement with the amount of coal purchased to avoid an unpleasant interview with the manager.

FIG. 1

These difficulties are easily avoided in a vessel using liquid fuel, for after a liquid fuel tank is once carefully measured and the capacity properly calculated and recorded for future use, the only requirement for obtaining a reliable record of the fuel consumption is reasonable accuracy on the part of the vessel's engineers in making the necessary measurements. These measurements should include the depth or ullage of the fuel in the tanks, and specific gravity and the temperature of the fuel, and in some vessels the draft of the vessel forward and aft, and the list of the vessel to starboard or port.

Since the measurement of the depth of the fuel in the tanks and the recording of the corresponding capacity must be made many times during the life of the vessel, it is evident that these operations should be made as simple and as free from chance of error as is consistent with accurate results. This should be done, even though the work involved in the first measurement of the capacity and in the preparation of capacity scales or diagrams is considerably increased to obtain that result, since this work is required but once.

There are two methods of measuring the depth of liquid in a tank in common use at present, namely, the sounding rod, used for measuring the distance from the surface of the liquid to the bottom of the tank, and the ullage stick or rod, used in measuring the distance from the surface of the liquid to the top of the tank.

The sounding rod as it is ordinarily used, while sufficiently accurate for the measurement of water ballast or other liquids of which only the approximate quantity is wanted, has several serious faults which render it unsuitable for the accurate measurement of liquid fuel. The most common trouble is the fact that sediment, dirt or other foreign substances may accumulate at the bottom of the sounding-tube and make the readings inaccurate and variable from time to time. A similar trouble, but one which applies to the construction of the capacity scales and not to the operation on board the vessel, is the difficulty of making a correct allowance for the depth or thickness of any cement used under the end of the sounding pipe. In the better class of work, however, cement is never used in the oil tanks.

Although the varieties of sounding rods are legion, perhaps the most common type is made from flat iron about ⅛ inch by ⅝ inch, with joints at short intervals, by means of which it may be folded so as to be easily stowed away in a small space. These joints also make the rod sufficiently flexible to pass around bends which are unfortunately sometimes placed in sounding pipes. As sounding pipes are usually made from 1½-inch standard pipe, it is always possible, and indeed probable, that careless use of the small, short section sounding rod will indicate a greater depth of liquid than actually exists, because the excessive clearance between the rod and the pipe allows the rod to shorten up under its own weight. This will be clearly seen by reference to Fig. 1, which shows the lower end of the sounding rod which has come in contact with the bottom of the tank.

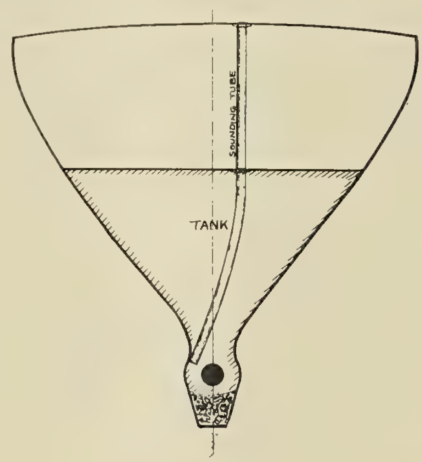


FIG. 2

Another fault, already suggested in the last paragraph, and which is of more common occurrence than it should be, is to place bends in the sounding pipe in order to clear obstructions that prevent a direct lead to the deepest part of the tank. It is evident that the difference in direction of the part above and the part below the bend will produce a difference in the rate of vertical travel of the rod as it is lowered into the sounding pipe, which will result in soundings exceeding the true vertical depth of the liquid. In approximate scales for capacity this change of rate could be allowed for, but for the best and most accurate work it is better to have all pipes straight.

Fig. 2 shows another source of error, this particular case occurring on a recently completed Government vessel. The rod here lands against the sloping side of the vessel and will seldom stop its downward course at the same point. Evidently the designer considered it more important to indicate the presence of the last drop of liquid than to have the soundings accurate.

It may be objected that these sources of error are of no great influence in the total capacity, and such indeed might

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON	SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
1.0000	10.0	8.3373	268.67	62.367	35.916	.9900	11.4	8.2539	271.39	61.743	36.279
.9995	10.1	8.3331	268.80	62.336	35.935	.9895	11.5	8.2497	271.52	61.712	36.298
.9990	10.1	8.3289	268.94	62.305	35.952	.9890	11.6	8.2455	271.67	61.681	36.316
.9985	10.2	8.3247	269.08	62.273	35.970	.9885	11.6	8.2414	271.80	61.650	36.334
.9980	10.3	8.3206	269.22	62.242	35.988	.9880	11.7	8.2372	271.94	61.619	36.353
.9975	10.4	8.3164	269.35	62.211	36.006	.9875	11.8	8.2330	272.17	61.587	36.372
.9970	10.4	8.3122	269.48	62.180	36.025	.9870	11.9	8.2289	272.21	61.556	36.390
.9965	10.5	8.3081	269.62	62.149	36.043	.9865	11.9	8.2247	272.35	61.525	36.408
.9960	10.6	8.3039	269.75	62.118	36.061	.9860	12.0	8.2205	272.49	61.494	36.426
.9955	10.6	8.2997	269.89	62.086	36.079	.9855	12.1	8.2164	272.63	61.463	36.445
.9950	10.7	8.2956	270.02	62.055	36.097	.9850	12.1	8.2122	272.77	61.431	36.463
.9945	10.8	8.2914	270.16	62.024	36.115	.9845	12.2	8.2080	272.90	61.400	36.482
.9940	10.9	8.2872	270.29	61.993	36.134	.9840	12.3	8.2039	273.04	61.369	36.500
.9935	10.9	8.2831	270.43	61.962	36.151	.9835	12.4	8.1997	273.18	61.338	36.518
.9930	11.0	8.2789	270.57	61.930	36.170	.9830	12.4	8.1955	273.32	61.307	36.538
.9925	11.1	8.2747	270.70	61.899	36.188	.9825	12.5	8.1914	273.46	61.276	36.556
.9920	11.1	8.2706	270.84	61.868	36.206	.9820	12.6	8.1872	273.60	61.244	36.575
.9915	11.2	8.2664	270.98	61.837	36.224	.9815	12.6	8.1830	273.74	61.213	36.593
.9910	11.3	8.2622	271.12	61.806	36.243	.9810	12.7	8.1788	273.88	61.182	36.612
.9905	11.4	8.2581	271.26	61.775	36.261	.9805	12.8	8.1747	274.02	61.151	36.631
.9900	11.4	8.2539	271.39	61.743	36.279	.9800	12.9	8.1705	274.16	61.120	36.649

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON	SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
.9800	12.9	8.1705	274.16	61.120	36.649	.9700	14.3	8.0871	276.98	60.496	37.027
.9795	12.9	8.1663	274.30	61.088	36.668	.9695	14.4	8.0830	277.13	60.465	37.046
.9790	13.0	8.1622	274.44	61.057	36.687	.9690	14.5	8.0788	277.27	60.434	37.065
.9785	13.1	8.1580	274.58	61.026	36.706	.9685	14.5	8.0746	277.41	60.402	37.085
.9780	13.2	8.1538	274.72	60.995	36.724	.9680	14.6	8.0705	277.56	60.371	37.104
.9775	13.2	8.1497	274.86	60.964	36.743	.9675	14.7	8.0663	277.70	60.340	37.123
.9770	13.3	8.1455	275.00	60.933	36.762	.9670	14.8	8.0621	277.84	60.309	37.142
.9765	13.4	8.1413	275.14	60.901	36.781	.9665	14.9	8.0580	277.99	60.278	37.161
.9760	13.4	8.1372	275.28	60.870	36.800	.9660	15.0	8.0538	278.13	60.247	37.181
.9755	13.5	8.1330	275.42	60.839	36.818	.9655	15.0	8.0496	278.27	60.215	37.200
.9750	13.6	8.1288	275.56	60.808	36.837	.9650	15.1	8.0455	278.42	60.184	37.219
.9745	13.7	8.1247	275.70	60.777	36.856	.9645	15.2	8.0413	278.56	60.153	37.238
.9740	13.7	8.1205	275.85	60.745	36.875	.9640	15.3	8.0371	278.71	60.122	37.258
.9735	13.8	8.1163	275.99	60.714	36.894	.9635	15.3	8.0329	278.85	60.091	37.277
.9730	13.9	8.1121	276.13	60.683	36.914	.9630	15.4	8.0288	279.00	60.059	37.296
.9725	13.9	8.1080	276.27	60.652	36.932	.9625	15.5	8.0246	279.14	60.028	37.316
.9720	14.0	8.1038	276.41	60.621	36.951	.9620	15.6	8.0204	279.29	59.997	37.335
.9715	14.1	8.0996	276.56	60.590	36.970	.9615	15.6	8.0163	279.43	59.966	37.355
.9710	14.2	8.0955	276.70	60.558	36.989	.9610	15.7	8.0121	279.58	59.935	37.374
.9705	14.2	8.0913	276.84	60.527	37.008	.9605	15.8	8.0079	279.72	59.904	37.393
.9700	14.3	8.0871	276.98	60.496	37.027	.9600	15.9	8.0038	279.87	59.872	37.413

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON	SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
.9600	15.9	8.0038	279.87	59.872	37.413	.9500	17.4	7.9204	282.81	59.249	37.807
.9595	16.0	7.9996	280.01	59.841	37.432	.9495	17.5	7.9162	282.96	59.217	37.827
.9590	16.1	7.9954	280.16	59.810	37.452	.9490	17.6	7.9121	283.11	59.186	37.847
.9585	16.1	7.9913	280.31	59.779	37.472	.9485	17.7	7.9079	283.26	59.155	37.867
.9580	16.2	7.9871	280.45	59.748	37.491	.9480	17.8	7.9037	283.41	59.124	37.887
.9575	16.3	7.9829	280.60	59.716	37.511	.9475	17.9	7.8995	283.56	59.093	37.906
.9570	16.3	7.9788	280.75	59.685	37.530	.9470	17.9	7.8954	283.71	59.062	37.926
.9565	16.4	7.9746	280.90	59.654	37.550	.9465	18.0	7.8912	283.86	59.030	37.947
.9560	16.5	7.9704	281.04	59.623	37.569	.9460	18.1	7.8870	284.01	58.999	37.967
.9555	16.6	7.9662	281.18	59.592	37.589	.9455	18.2	7.8829	284.16	58.968	37.987
.9550	16.7	7.9621	281.33	59.560	37.609	.9450	18.2	7.8787	284.31	58.937	38.007
.9545	16.7	7.9579	281.48	59.529	37.628	.9445	18.3	7.8745	284.46	58.906	38.027
.9540	16.8	7.9537	281.62	59.498	37.648	.9440	18.4	7.8704	284.61	58.874	38.047
.9535	16.9	7.9496	281.78	59.467	37.668	.9435	18.4	7.8662	284.76	58.843	38.067
.9530	17.0	7.9454	281.92	59.436	37.688	.9430	18.5	7.8620	284.92	58.812	38.087
.9525	17.1	7.9412	282.07	59.405	37.708	.9425	18.6	7.8579	285.06	58.781	38.108
.9520	17.1	7.9371	282.22	59.373	37.727	.9420	18.7	7.8537	285.22	58.750	38.128
.9515	17.2	7.9.329	282.37	59.342	37.747	.9415	18.8	7.8495	285.37	58.719	38.148
.9510	17.3	7.9.287	282.52	59.311	37.767	.9410	18.9	7.8454	285.52	58.687	38.168
.9505	17.4	7.9.246	282.67	59.280	37.787	.9405	18.9	7.8412	285.67	58.656	38.189
.9500	17.4	7.9.204	282.81	59.249	37.807	.9400	19.0	7.8370	285.82	58.625	38.209

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLONS	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON	SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.9400	19.0	7.8370	285.82	58.625	38.209	.9300	20.7	7.7536	288.90	58.001	38.620
.9395	19.1	7.8329	285.98	58.594	38.229	.9295	20.8	7.7495	289.05	57.970	38.641
.9390	19.2	7.8287	286.13	58.563	38.250	.9290	20.8	7.7453	289.21	57.938	38.661
.9385	19.2	7.8245	286.28	58.531	38.270	.9285	20.9	7.7411	289.36	57.908	38.682
.9380	19.3	7.8203	286.43	58.500	38.290	.9280	21.0	7.7370	289.52	57.877	38.703
.9375	19.4	7.8162	286.59	58.469	38.311	.9275	21.1	7.7328	289.68	57.845	38.724
.9370	19.5	7.8120	286.74	58.438	38.331	.9270	21.2	7.7286	289.83	57.814	38.745
.9365	19.6	7.8078	286.89	58.407	38.352	.9265	21.2	7.7245	289.99	57.783	38.766
.9360	19.6	7.8037	287.04	58.376	38.372	.9260	21.3	7.7203	290.14	57.752	38.787
.9355	19.7	7.7995	287.20	58.344	38.393	.9255	21.4	7.7161	290.30	57.721	38.808
.9350	19.8	7.7953	287.35	58.313	38.413	.9250	21.5	7.7120	290.46	57.689	38.829
.9345	19.9	7.7912	287.51	58.282	38.434	.9245	21.6	7.7078	290.61	57.658	38.850
.9340	20.0	7.7870	287.66	58.251	38.454	.9240	21.7	7.7036	290.77	57.627	38.871
.9335	20.1	7.7828	287.81	58.220	38.475	.9235	21.8	7.6994	290.93	57.596	38.892
.9330	20.2	7.7787	287.97	58.188	38.496	.9230	21.9	7.6953	291.09	57.565	38.913
.9325	20.2	7.7745	288.12	58.157	38.516	.9225	21.9	7.6911	291.25	57.534	38.934
.9320	20.3	7.7703	288.28	58.126	38.537	.9220	22.0	7.6869	291.40	57.502	38.955
.9315	20.4	7.7662	288.43	58.095	38.558	.9215	22.1	7.6828	291.56	57.471	38.976
.9310	20.5	7.7620	288.59	58.064	38.578	.9210	22.2	7.6786	291.72	57.440	38.997
.9305	20.6	7.7578	288.74	58.032	38.599	.9205	22.3	7.6744	291.88	57.409	39.018
.9300	20.7	7.7536	288.90	58.001	38.620	.9200	22.4	7.6703	292.04	57.378	39.040

TABLES SHOWING PHYSICAL PROPERTIES OF OILS USED FOR LIQUID FUEL

Specific Gravity	Beaume Scale	Pounds per U.S. Gallon	U.S. Gallons per Ton	Pounds per Cubic Foot	Cubic Feet per Ton
.9200	22.4	7.6703	292.04	57.378	39.040
.9195	22.5	7.6661	292.20	57.346	39.061
.9190	22.5	7.6619	292.35	57.315	39.082
.9185	22.6	7.6578	292.51	57.284	39.103
.9180	22.7	7.6536	292.67	57.253	39.125
.9175	22.8	7.6494	292.83	57.222	39.146
.9170	22.9	7.6453	292.99	57.191	39.167
.9165	23.0	7.6411	293.15	57.159	39.189
.9160	23.1	7.6369	293.31	57.128	39.210
.9155	23.1	7.6328	293.47	57.097	39.232
.9150	23.2	7.6286	293.63	57.066	39.253
.9145	23.3	7.6244	293.79	57.035	39.274
.9140	23.4	7.6203	293.95	57.003	39.296
.9135	23.5	7.6161	294.11	58.972	39.317
.9130	23.6	7.6119	294.28	56.941	39.339
.9125	23.7	7.6077	294.44	56.910	39.360
.9120	23.7	7.6036	294.60	56.879	39.382
.9115	23.8	7.5994	294.76	56.848	39.404
.9110	23.9	7.5952	294.92	56.816	39.425
.9105	24.0	7.5911	295.08	56.785	39.447
.9100	24.1	7.5869	295.25	56.754	39.469
.9100	24.1	7.5869	295.25	56.754	39.469
.9095	24.2	7.5827	295.41	56.723	39.490
.9090	24.3	7.5786	295.57	56.692	39.512
.9085	24.3	7.5744	295.73	56.660	39.534
.9080	24.4	7.5702	295.90	56.629	39.556
.9075	24.5	7.5661	296.06	56.598	39.577
.9070	24.6	7.5619	296.22	56.567	39.599
.9065	24.7	7.5577	296.38	56.536	39.621
.9060	24.7	7.5536	296.55	56.505	39.643
.9055	24.8	7.5494	296.71	56.473	39.665
.9050	24.9	7.5452	296.88	56.442	39.687
.9045	25.0	7.5410	297.04	56.411	39.709
.9040	25.1	7.5369	297.21	56.380	39.731
.9035	25.2	7.5327	297.37	56.349	39.753
.9030	25.3	7.5285	297.53	56.317	39.775
.9025	25.4	7.5244	297.70	56.286	39.797
.9020	25.4	7.5202	297.86	56.255	39.819
.9015	25.5	7.5160	298.03	56.224	39.841
.9010	25.6	7.5119	298.19	56.193	39.863
.9005	25.7	7.5077	298.36	56.161	39.885
.9000	25.8	7.5035	298.53	56.130	39.907
.9000	25.8	7.5035	298.53	56.130	39.907
.8995	25.9	7.4994	298.69	56.099	39.929
.8990	26.0	7.4952	298.86	56.068	39.952
.8985	26.0	7.4910	299.02	56.037	39.974
.8980	26.1	7.4869	299.19	56.006	39.996
.8975	26.2	7.4827	299.36	55.974	40.018
.8970	26.3	7.4785	299.53	55.943	40.041
.8965	26.4	7.4743	299.69	55.912	40.063
.8960	26.5	7.4702	299.86	55.881	40.085
.8955	26.6	7.4660	300.03	55.850	40.108
.8950	26.6	7.4618	300.19	55.818	40.130
.8945	26.7	7.4577	300.36	55.787	40.153
.8940	26.8	7.4535	300.53	55.756	40.175
.8935	26.9	7.4493	300.70	55.725	40.197
.8930	27.0	7.4452	300.87	55.694	40.220
.8925	27.1	7.4410	301.03	55.663	40.242
.8920	27.2	7.4368	301.20	55.631	40.265
.8915	27.2	7.4327	301.37	55.600	40.288
.8910	27.3	7.4285	301.54	55.569	40.310
.8905	27.4	7.4243	301.71	55.538	40.333
.8900	27.5	7.4202	301.88	55.507	40.336
.8900	27.5	7.4202	301.88	55.507	40.336
.8895	27.6	7.4160	302.05	55.475	40.378
.8890	27.7	7.4118	302.22	55.444	40.401
.8885	27.8	7.4077	302.39	55.413	40.424
.8880	27.8	7.4035	302.56	55.382	40.446
.8875	27.9	7.3993	302.73	55.351	40.469
.8870	28.0	7.3951	302.90	55.320	40.492
.8865	28.1	7.3910	303.07	55.288	40.515
.8860	28.2	7.3868	303.24	55.257	40.538
.8855	28.3	7.3826	303.41	55.226	40.561
.8850	28.4	7.3785	303.59	55.195	40.584
.8845	28.4	7.3743	303.76	55.164	40.606
.8840	28.5	7.3701	303.93	55.132	40.629
.8835	28.6	7.3660	304.10	55.101	40.652
.8830	28.7	7.3618	304.27	55.070	40.675
.8825	28.8	7.3576	304.45	55.039	40.699
.8820	28.9	7.3535	304.62	55.008	40.722
.8815	29.0	7.3493	304.79	54.977	40.745
.8810	29.1	7.3451	304.96	54.945	40.768
.8805	29.1	7.3409	305.14	54.914	40.791
.8800	29.2	7.3368	305.31	54.883	40.814
.8800	29.2	7.3368	305.31	54.883	40.814
.8795	29.3	7.3326	305.48	54.852	40.837
.8790	29.4	7.3284	305.66	54.821	40.861
.8785	29.5	7.3243	305.83	54.789	40.884
.8780	29.6	7.3201	306.01	54.758	40.907
.8775	29.7	7.3159	306.18	54.727	40.930
.8770	29.7	7.3118	306.36	54.696	40.954
.8765	29.8	7.3076	306.53	54.665	40.977
.8760	29.9	7.3034	306.71	54.633	41.001
.8755	30.0	7.2993	306.88	54.602	41.024
.8750	30.1	7.2951	307.06	54.571	41.047
.8745	30.2	7.2909	307.23	54.540	41.071
.8740	30.3	7.2868	307.41	54.509	41.094
.8735	30.3	7.2826	307.58	54.478	41.118
.8730	30.4	7.2784	307.76	54.446	41.141
.8725	30.5	7.2743	307.94	54.415	41.165
.8720	30.6	7.2701	308.11	54.384	41.189
.8715	30.7	7.2659	308.29	54.353	41.212
.8710	30.8	7.2617	308.47	54.322	41.236
.8705	30.9	7.2576	308.64	54.290	41.260
.8700	31.0	7.2534	308.82	54.259	41.283
.8700	31.0	7.2534	308.82	54.259	41.283
.8695	31.1	7.2492	309.00	54.228	41.307
.8690	31.2	7.2451	309.18	54.197	41.331
.8685	31.3	7.2409	309.35	54.166	41.355
.8680	31.4	7.2367	309.53	54.135	41.378
.8675	31.5	7.2326	309.71	54.103	41.402
.8670	31.6	7.2284	309.89	54.072	41.426
.8665	31.7	7.2242	310.07	54.041	41.450
.8660	31.8	7.2201	310.25	54.010	41.474
.8655	31.9	7.2159	310.43	53.979	41.498
.8650	32.0	7.2117	310.61	53.947	41.522
.8645	32.1	7.2076	310.78	53.916	41.546
.8640	32.2	7.2034	310.97	53.885	41.570
.8635	32.3	7.1992	311.14	53.854	41.594
.8630	32.4	7.1951	311.33	53.823	41.618
.8625	32.5	7.1909	311.51	53.792	41.642
.8620	32.5	7.1867	311.69	53.760	41.666
.8615	32.6	7.1825	311.87	53.729	41.691
.8610	32.7	7.1784	312.05	53.698	41.715
.8605	32.8	7.1742	312.23	53.667	41.739
.8600	32.9	7.1700	312.41	53.636	41.763
.8600	32.9	7.1700	312.41	53.636	41.763
.8595	33.0	7.1659	312.59	53.604	41.787
.8590	33.1	7.1617	312.77	53.573	41.812
.8585	33.2	7.1575	312.96	53.542	41.836
.8580	33.3	7.1534	313.14	53.511	41.861
.8575	33.4	7.1492	313.32	53.480	41.885
.8570	33.5	7.1450	313.51	53.449	41.909
.8565	33.6	7.1409	313.69	53.417	41.934
.8560	33.7	7.1367	313.87	53.386	41.959
.8555	33.8	7.1325	314.05	53.355	41.984
.8550	33.9	7.1284	314.24	53.324	42.008
.8545	34.0	7.1242	314.42	53.293	42.032
.8540	34.1	7.1200	314.61	53.261	42.057
.8535	34.1	7.1158	314.79	53.230	42.081
.8530	34.2	7.1117	314.97	53.199	42.106
.8525	34.3	7.1075	315.16	53.168	42.131
.8520	34.4	7.1033	315.34	53.137	42.155
.8515	34.5	7.0992	315.53	53.106	42.180
.8510	34.6	7.0950	315.72	53.074	42.205
.8505	34.7	7.0908	315.90	53.043	42.230
.8500	34.8	7.0867	316.09	53.012	42.255
.8500	34.8	7.0867	316.09	53.012	42.255
.8495	34.9	7.0825	316.27	52.981	42.280
.8490	35.0	7.0783	316.46	52.950	42.304
.8485	35.1	7.0742	316.65	52.918	42.329
.8480	35.2	7.0700	316.83	52.887	42.354
.8475	35.3	7.0658	317.02	52.856	42.379
.8470	35.4	7.0617	317.21	52.825	42.404
.8465	35.5	7.0575	317.39	52.794	42.429
.8460	35.6	7.0533	317.58	52.762	42.454
.8455	35.7	7.0491	317.77	52.731	42.480
.8450	35.8	7.0450	317.96	52.700	42.505
.8445	35.9	7.0408	318.14	52.669	42.530
.8440	36.0	7.0366	318.33	52.638	42.555
.8435	36.1	7.0325	318.52	52.607	42.580
.8430	36.2	7.0283	318.71	52.575	42.605
.8425	36.3	7.0241	318.90	52.544	42.631
.8420	36.4	7.0200	319.09	52.513	42.656
.8415	36.5	7.0158	319.28	52.482	42.681
.8410	36.7	7.0116	319.47	52.451	42.707
.8405	36.8	7.0075	319.66	52.419	42.732
.8400	36.9	7.0033	319.85	52.388	42.758

TABLES SHOWING PHYSICAL PROPERTIES OF OILS USED FOR LIQUID FUEL

be the case if a tank had small horizontal dimensions combined with considerable depth. But in the tank of ordinary proportions the error from this source may be important. The settling tank is the most convenient place in which to measure the consumption of oil for short periods of time, and in such tank the error in capacity due to only ¼ inch error in the sounding has been known to exceed four percent of the amount of fuel oil in the tank at the time the soundings were made—enough to materially affect the figures for fuel economy.

The second method of measurement in common use, by "ullage," is used almost exclusively by the owners of vessels used for transporting oil in bulk; and as it is customary to check all receipts and deliveries of the oil by this method, its continued use is good evidence of its superior accuracy.

In using this method, recent practice is to place a small hand-hole as near to the center of the tank as possible, the opening being provided with an oil-tight cover which is secured so as to be readily opened by the removal of a toggle pin. No sounding pipe is fitted (though there should be one fitted, for reasons that will appear later), and measurements are always taken from the top edge of the handhole rim to the surface of the liquid. This distance is known to those in the oil carrying trade as the "ullage" of the tank.

It is evident, upon comparing this method of measurement with the first, that the measurements are less liable to be in error (even when made by unskilled men), for the following reasons:

(*a*) There is no possibility of foreign substances, sediment, or cement affecting either the ullage measurement or the capacity calculations.

(*b*) There is no chance of error because of knuckles in the sounding pipe.

(*c*) As the sounding rod does not come in contact with the bottom of the tank, errors from that source are avoided.

(*d*) The thickness of the tank top plating and the depth of the handhole rim are quite easily measured and can be accurately allowed for in making the capacity scales or diagrams.

(*e*) Capacity scales, made to read ullage depths, are used and understood as easily as those made to suit soundings.

Granting, then, that by the ullage method of measurement the amount of oil can be accurately determined, there remain four other measurements which for some vessels must be included in the engineer's reports, namely, draft of the vessel forward and aft, the list of the ship and whether to starboard or port, the temperature of the liquid fuel, and also the specific or Baumé gravity of the liquid fuel. These will be considered in the order given.

Where the tanks used for measuring the fuel are short in proportion to the length of the vessel, the draft carefully read by eye from the draft marks is sufficiently accurate for all practical purposes. When, however, the tank is relatively long, or extreme accuracy is for any reason desirable, internal draft gages should be fitted to make exact draft readings possible. These gages are made of a glass tube or tubes of sufficient length to cover the range of the draft of the vessel, open at the upper end to the air and connected to the sea at the lower end through a valve which serves to shut off the connection when the tube is not in use, and also to check the motion of the water in the tube, due to the influence of the waves, by partially closing the valve and so wire-drawing the flow of water. A drain-cock is fitted to clear the gage of water after it has been in use, and also to allow a flow of water to be maintained through the pipe before readings are taken so that the water in the pipe will be of the same temperature and specific gravity as the sea water at the time the draft readings are taken. A scale, carefully graduated to read heights above the bottom of the keel is permanently secured alongside the glass tube so that the draft of the vessel may be read without the use of a rule.

The list of the ship to starboard or to port should be read from the ship's clinometer in vessels where the sounding tube is not on the center-line of the tank, or the tank or tanks used for measuring the fuel consumption are not symmetrical about their center-lines.

As all liquids expand or contract with changes in temperature, any attempt to obtain accurate records of fuel oil consumption must include a record of the temperature. In bulk oil cargo vessels it is usual to furnish the ship with a thermometer which is known to be accurate, and when the temperature of the oil is required it is lowered by means of a cord or wire, through the handhole, to a position approximately at the center of the volume of the oil. It is allowed to remain there sufficiently long for it to reach the same temperature as the oil, and the reading is taken immediately upon its withdrawal. When the tank is deep and the heavier portion of the oil gravitates toward the bottom of the tank, or when extremely accurate results are desired, the thermometer should be secured within a large weighted bottle, fitted with a stopper which can be pulled out by a separate line after the bottle is lowered in the tank. If the bottle is rapidly drawn to the surface the sample of oil contained can be tested for specific gravity and the temperature determined at the same time. In a deep tank this information should be obtained for at least three different depths, the bottom, the middle and the top of the tank and the average taken for use in obtaining the amount of oil in the tank.

Nearly all large sales and purchases of fuel oil are for a specified volume, either barrels (at 42 gallons per barrel) or gallons, at a temperature of 60 degrees Fahrenheit, and therefore it is customary to correct all measured capacities to the standard temperature of 60 degrees Fahrenheit to render direct comparison of different vessels, or of the same vessel at different times, possible. The rate of expansion, commonly expressed as a coefficient of expansion for one degree, varies with the specific gravity of the oil, but a rate of 1 percent for every twenty degrees Fahrenheit change in temperature (coefficient 0.0005) may be taken as a good average for any oil commonly used for fuel oil.

For an intelligent analysis of the results of the fuel it is necessary to know the grade of the oil used. The grade is usually recognized by the color, smell, specific gravity, flash and firing points of the oil used, but for fuel oil the only property that is ordinarily used is the specific gravity. This is usually given in degrees on the Baumé scale, the hydrometer in common use for this purpose being graduated to that scale.

The equivalent specific gravity, Baumé gravity, weight per cubic foot, cubic feet per ton, weight per U. S. gallon (231 cubic inches), and U. S. gallons per ton are given in the tables (see pages 307 and 308), throughout the range of values required for oils that are used for fuel oil.

(To be concluded)

At a meeting of the Committee of Manufacturers on Standardization of Fittings and Valves, held in New York, July 10, the "Manufacturers'" 1912 Schedule of Flanged Fittings and Flanges was adopted, to take effect Oct. 1, 1912. There was practically no opposition among the manufacturers present to the adoption of this schedule, but one vote being recorded against it. Copies of this schedule will be printed and distributed to the manufacturers and the trade generally as soon as possible. New list prices for brass and iron body swing check valves, standard and extra heavy, were adopted at this meeting, to take effect Oct. 1, 1912, copies of which will be printed and distributed to the trade as promptly as possible.

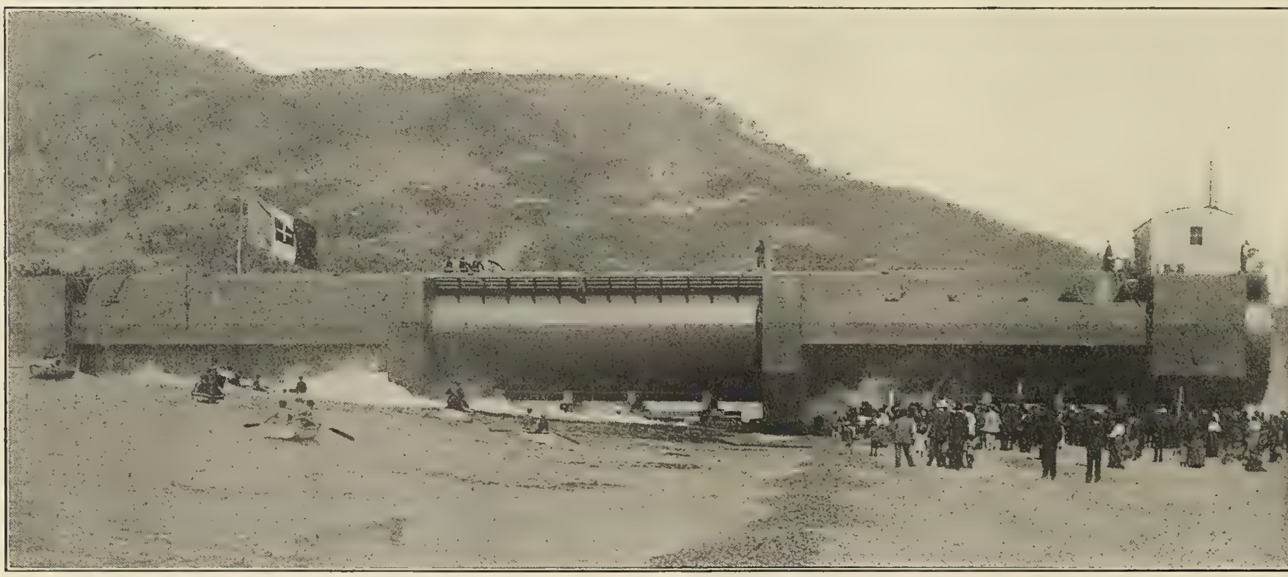
A Combined Salvage and Testing Dock for Submarine Boats

BY ROBERT G. SKERRETT

The Italian Government, within the past few months, has added a novel auxiliary to its naval facilities. This is a combined salvage and testing dock for under-water boats. The primary purpose of the apparatus is to provide a safe and flexible means for trying out submarines under circumstances duplicating the stresses of deep submergence without actually sinking the boats to depths of corresponding hydrostatic pressure. This means that the subaqueous vessel can be tested at any convenient place—preferably the building yard—instead of taking her to some out-of-the-way part of the coast, perhaps exposed, for the purpose of finding water deep enough for actual submergence so many feet down. In the very deep trials for hull strength, generally no one goes down in the boats, and much information could be obtained were inspectors aboard at that time. However, as things are, the element of risk seems to be too great to warrant the hazard of human life, and yet the safety of the crew later on may hinge on the very data which are now not attainable as the tests are ordinarily conducted. The existing facilities employed in this work here are not flexible enough to lend themselves readily to a secure and speedy handling of the submarine when lowered to great depths and with examiners on board. In brief, this is the general state of the art so far as testing facilities for under-water boats commonly exist, but fortunately the special dock just added to the Italian navy promises a revolution and a very material betterment in the dealing with problems associated with some phases of under-water navigation.

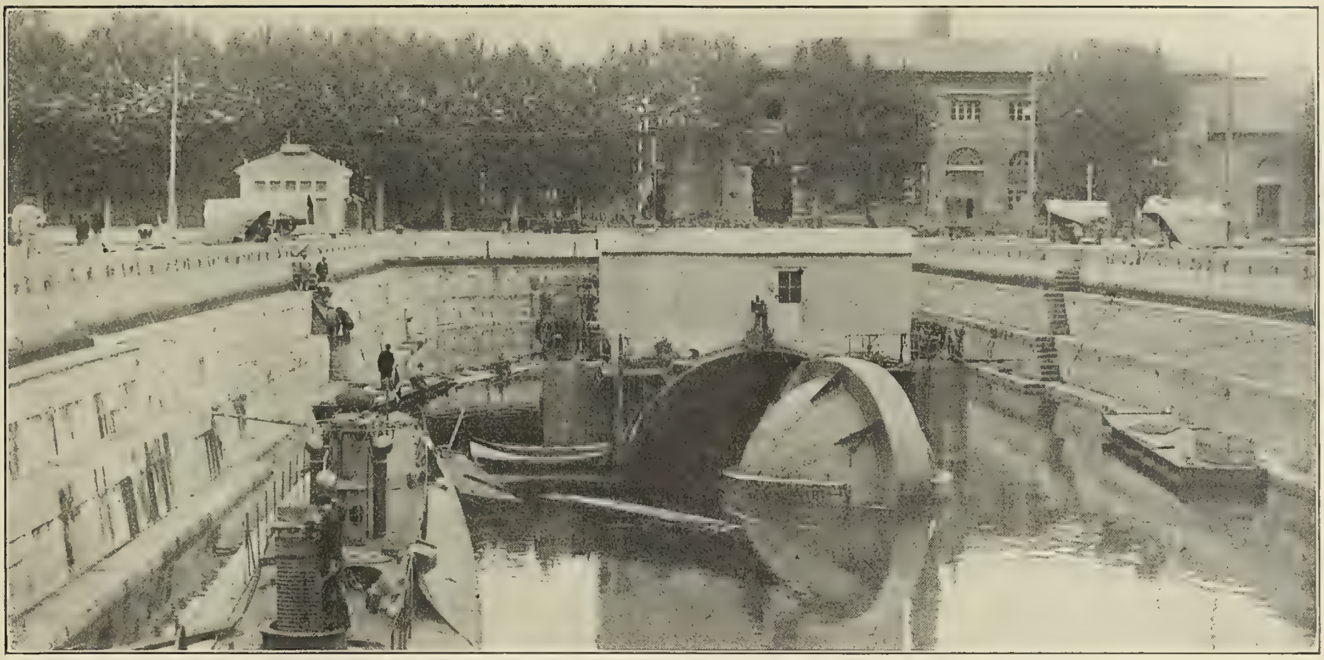
Designs are already prepared for a dock of this sort large enough to meet the requirements of a submarine quite 200 feet long and having a displacement of possibly 400 tons or more. An apparatus of these proportions would have an overall length of about 235 feet, and, empty, a displacement of 500 metric tons upon a mean draft of 7 feet. At its deepest draft, when flooded and submerged sufficiently for the entrance of a submarine, the dock would have an average draft of 17 feet 9 inches. With the dock closed and ready to be docked itself, with a submarine inside, the mean draft would be substantially 10 feet. This would be the condition, too, with the dock in a state to test a submarine under pressure—the space around the submarine being flooded.

The general arrangement of the dock is quite simple, and one cannot help but marvel at the delay in its development, remembering as we do the number of accidents which resulted fatally because of insufficient structural strength. The testing dock consists fundamentally of a cylindrical steel body or tube of such strength that it can endure safely a bursting pressure exerted by contained water equivalent to a sea pressure at a depth of more than 300 feet. This tubular body is permanently closed at one end, and at the other there is a removable caisson or stopper which closes the opening through which a submarine may enter or leave the dock. The inside of the tube has a series of rails upon which can be laid keel blocks to support the vessel undergoing test, and other blocks or chocks secure the boat in position so that she cannot shift vertically when the cylinder is flooded. The cylinder is sustained by encompassing caissons, which are flooded or drained as occasion requires in order to sink or raise the dock bodily. The water entering the tubular structure does so through the ballast tanks, and is again withdrawn through the same channels. This simplifies operations and facilitates a nicer control of the water. When the submarine has been landed, so to speak, inside of the dock, the movable gate is swung into position and the cylinder sealed.



LAUNCH OF THE LAURENTI SALVAGE AND TESTING DOCK AT SPEZIA

In order to subject the submarine to external stress, pressure is applied to the water filling the tube, and surrounding the submarine, by means of a special steam pump. Gradually the pump forces the pressure higher and higher until the desired limit is reached—all the while the boat is really only at normal surface and lying, perhaps, right at the wharf of the shipyard; but, even more important than this, observers are inside the submarine and are able to watch every physical effect of the crushing pressures exerted upon the hull. The examiners are in touch by telephone with the operators of the dock and the pressure pump, and complete co-operation is thus secured—it being possible to reduce the stresses very quickly should any serious or dangerous signs of yielding manifest themselves. The conditions involved in the applica-

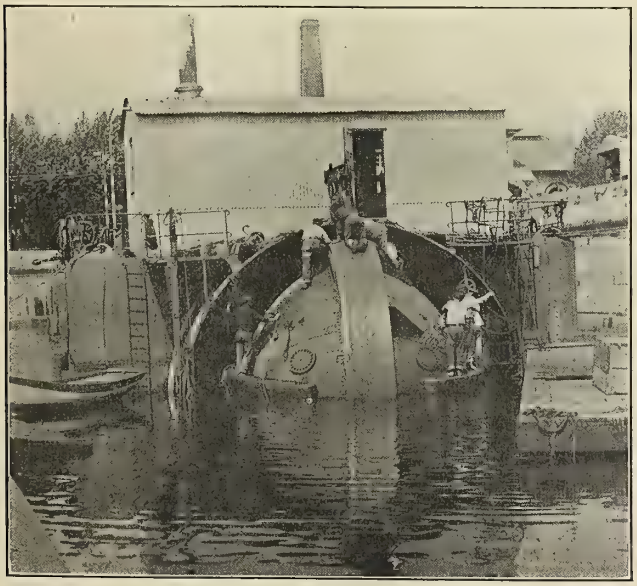


ENTRANCE GATE BEING SWUNG TO ONE SIDE PREPARATORY TO ADMITTING SUBMERSIBLE TO DOCK

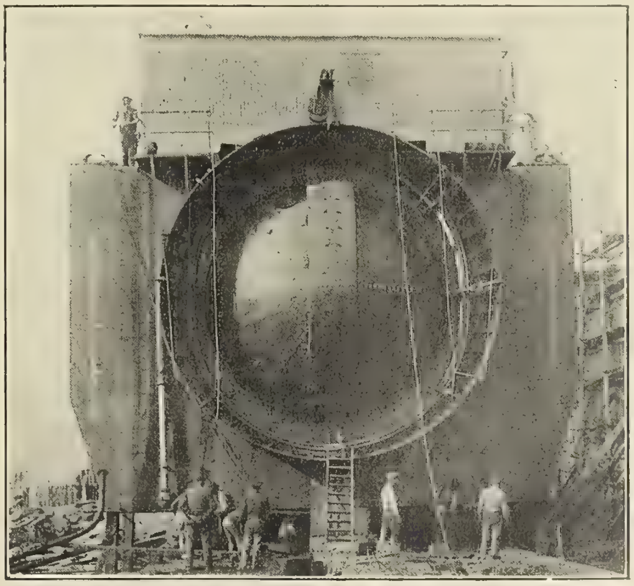
tion of the Laurenti dock are thus a very happy contrast to those present at the general function of a deep trial submergence for hull strength. Besides eliminating a large element of guesswork, the Laurenti apparatus makes it possible to obtain definite and conclusive data which are now denied by the physical circumstances of testing and the absence of inspectors during the deep submergence of the submarine. The time element which bears importantly upon the problem can be lengthened to any desired period, and the submarine in the testing dock can be held at a chosen pressure—corresponding to a given depth—as long as there is any need. All of these functions can be executed without regard to the state of the weather and the condition of exposed water, and a maximum depth of less than 20 feet is sufficient to meet every requirement. This is certainly a contrast to going somewhere off the coast and sending the submarine down 200 feet attached to the clumsy, slow-working facilities of an ordinary wrecking derrick.

There are other things that affect the safety of a submarine submerged deeply besides the single question of hull strength. These are the manner of working of the pumps designed to handle ballast against high external pressures; the sufficiency of the air system to expel water under similar conditions; the water tightness of torpedo tubes, certain stuffing boxes, and kindred outboard passageways; and, equally vital, the proper seating and strength of sea valves and allied connections which may be directly exposed to external pressures. The Laurenti dock makes it possible to answer all of these questions completely and satisfactorily. A boat so tested can be put into service with an assured margin of safety which would not only mean greater security for her crew, but possibly a degree of operative efficiency which must now be largely a matter of speculation in some directions.

We must not forget that submarine navigation has been a practical and commercial accomplishment of scarcely more than a term of ten years, and within the last five years tremendous advances have been made. In a large measure much of this improvement is due to changes in the form of hull—breaking away from the traditional spindle of circular cross-section. The gradual trend toward a modified shipshape body,



CLOSING THE ENTRANCE GATE



ENTRANCE END OF DOCK CLOSED

so as to get relatively high speeds, both submerged and on the surface, associated with seaworthiness, has added expense and structural difficulties in order to obtain the needful unit strength of section. This has introduced some factor of doubt, because all of these changes of form are based upon empirical formulæ. Now the Laurenti dock gives to the designer an instrument by which experimental sections can be submitted to test at small expense, and changes in the weights of parts and arrangement of the material can be studied practically at first hand. This obviates the building of an entire submarine speculatively and deferring knowledge until after a heavy outlay—knowledge which, when it arrives, may bring disappointment. In a sense, then, the invention of Major Cesare Laurenti is a counterpart, in its particular department, of the advantages to be obtained by the broadly recognized model experimental basin. It permits the attainment of information in advance of construction, which is of prime importance, and it also reduces the testing of the submarine already built to a line of scientific procedure which can not fail to furnish invaluable data.

The dock, as built for the Italian Government, carries its own power plant, and is furnished with both steam and electric pumps, the latter being of the centrifugal type and designed to handle the water ballast generally. The dock has no powers of self-propulsion, and must be towed from place to place if needed. This would probably be required should the dock be used for salvage purposes. It has a lifting capacity of more than 400 tons, and this would be ample to raise a sunken submarine, enough to carry her into shallow water or, perhaps, into harbor for dry-docking. The Laurenti dock is provided with the equipment needful to carry out an operation of this sort. This gives us a fairly good idea of the comprehensive capacity and flexibility of application of this Italian innovation.

The submarine has brought its own problems, and these can be mastered or met only by providing proper auxiliaries. The parent ship was the first of these adjuncts, the salvage dock, pure and simple, was the next, and now we have the composite creation designed by Major Laurenti, which may quite truly be said to be the present climax of associate equipment.

Latest Clyde-Built Scout Cruiser

The *Dublin*, recently launched from the Naval Construction Works of Messrs. William Beardmore & Company, Dalmuir, is one of three vessels of the "Town" type under construction—the *Chatham*, launched at Chatham in November last, and the Southampton, under construction at Clydebank, are her sister ships. Of the "Scout" class of cruiser twenty-one vessels have been constructed, and the following shows the Clyde-built specimens and their gradual development in size and power:

	Feet.	Tons.	H. P.	Knots.	Builders.
Foresight, Forward	360	2,850	15,000	25.00	Fairfield.
Glasgow	430	4,800	22,000	25.00	Fairfield.
Gloucester	430	4,800	22,000	25.00	Beardmore.
Bristol	430	4,800	22,000	25.00	Clydebank.
Falmouth	430	5,250	22,000	24.75	Beardmore.
Yarmouth	430	5,250	22,000	24.75	London & Glasgow Co
Dublin	430	5,400	25,000	25.5	Beardmore.
Southampton	430	5,400	25,000	25.5	Clydebank.

The speeds of the completed vessels have been remarkably good, and in every case the contract has been well exceeded. The *Glasgow* attained a speed of 26.7 knots, the *Gloucester* 26.3, and the *Bristol* 26.8, while the *Falmouth* and *Yarmouth* were equally successful. In the *Bristol* and *Yarmouth* Brown-Curtis turbines, with a twin-screw arrangement, were installed and have proved most economical. The *Southampton* has a similar installation. The others had Parsons turbines and four screws, and this arrangement is adopted in the *Dublin*.

The advancement in displacement from the initial cruisers of this type has been caused by the increase in armament, better protection and increase in the radius of action. The *Foresight* and *Forward* mounted fourteen 12-pounder guns, had a coal capacity of 380 tons, and an armored deck 1½ inches in thickness. The *Dublin* mounts eight 6-inch guns and eight smaller weapons, has a capacity for 1,000 tons of coal, and, besides having protective deck, has armored protection on the sides. This departure is the feature of the new vessels, which in size and power approach first-class cruisers. The type has not advanced in length, being still about 450 feet, but their breadth, draft and displacement have been increased gradually in each succeeding naval programme, and in the *Dublin* they reach a beam of about 50 feet, with a displacement of 5,500 tons and a draft of 16 feet. The increase of about 15 percent in displacement has been utilized to improve the seagoing qualities of the vessels and to provide increased protection and more powerful armament.

In appearance the new scout vessel resembles the other cruisers of the "Town" class with four funnels and two masts. Steam will be supplied by twelve boilers of the Yarrow type, fitted for liquid fuel as well as for coal. The estimated cost of the *Dublin* is $1,630,000 (£334,058), and of the *Southampton* $1,620,000 (£333,078). The new vessels, of greater displacement, are being built cheaper than the earlier and smaller ships. In the vessels of 4,800 tons displacement the *Bristol* cost $1,780,000 (£365,000), or $370 (£76) per ton, the *Glasgow* $1,730,000 (£355,000), or $360 (£73.9) per ton, and the *Gloucester* $1,725,000 (£354,000), or $359 (£73.7) per ton. In the vessels of 5,250 tons displacement the *Falmouth* cost $1,650,000 (£337,500), or $314 (£64.3) per ton, and the *Yarmouth* $1,724,000 (£353,238), or $328 (£67.28) per ton. The new vessels show a corresponding decrease. The estimated cost of the *Dublin* works out at $302 (£61.86) per ton, and that of the *Southampton* $301 (£61.68) per ton. This shows an average reduction of $58.5 (£12) per ton in four years.

The keel of the *Dublin* was laid on April 6, 1911. The average time taken for the construction of ships of this class is about twenty months. The *Dublin* should therefore be commissioned about November.

During the year ended June 30, 1912, there were built in the United States and officially numbered by the Bureau of Navigation, 1702 merchant vessels of 243,792 gross tons, compared with 1,208 of 302,158 gross tons for the same period of 1911, showing a loss of 58,366 tons. Of the 35 metal vessels built on the Great Lakes, the *Col. James M. Schoonmaker* and *William P. Snyder, Jr.*, each of 8,603 gross tons, are the largest on the Lakes. Fourteen others, aggregating 30,029 tons, were built for the Atlantic trade. Over 50,000 gross tons of sailing vessels were lost at sea during the year, equivalent in tonnage to vessels built of this class for the last three years.

The returns compiled by *Lloyd's Register of Shipping*, which only take into account vessels the construction of which has actually begun, show that, excluding warships, there were 529 vessels of 1,774,040 tons gross under construction in the United Kingdom at the close of the quarter ended June 30, 1912. The tonnage now under construction is about 87,000 tons more than that which was in hand at the end of last quarter, and exceeds by 298,000 tons the tonnage building in June, 1911, the present figures being the highest ever recorded in the society's quarterly returns. The figures for warship tonnage, 503,003 tons, are also record figures; the previous highest total of 454,110 tons having been attained in March, 1900.

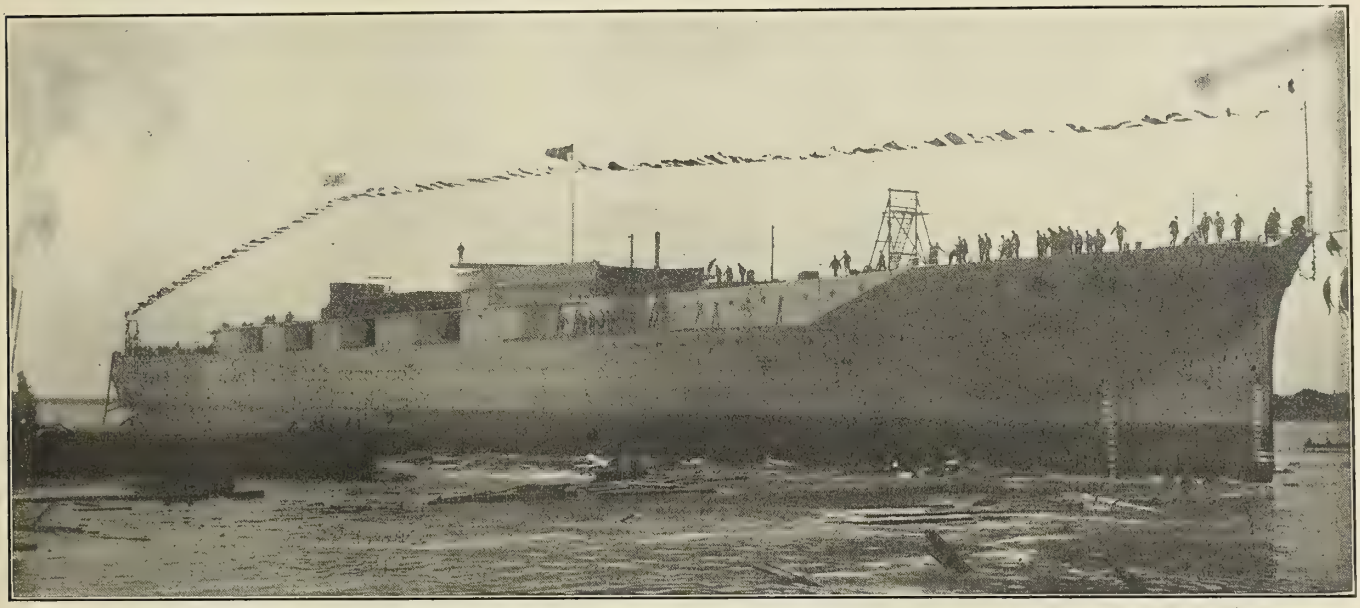
The New Japanese Battle Cruisers—Launch of the Kongo

BY F. C. COLEMAN

Four battle cruisers are now being completed for the Japanese navy, the strategical and tactical qualities governing the design having been enunciated by the Japanese Navy Department from experience gained in the Russo-Japanese war, while it was left to Messrs. Vickers, Ltd., of Barrow-in-Furness, to embody the stipulated requirements, which included the armament, the arrangement of the armament, the speed and radius of action on the smallest and most economical ship, alike in respect to first cost and fuel consumption for all speeds, and the expenses of maintaining the ship in commission.

Three of these battle cruisers are being built in Japan—the *Hiyei* at Yokosuka dockyard, the *Haruna* at Kobe, and the *Kirishima* at Nagasaki, while the fourth, the *Kongo*, is being constructed by Messrs. Vickers, Ltd., at Barrow-in-Furness, to fire all four guns astern in line with the keel. It is important to note that the Japanese authorities have considered it necessary to arrange that four guns should be fired astern.

An important development was also introduced in connection with the 6-inch guns, which are of 50 calibers in length. These are fitted in casemates on the upper deck level. The advantage achieved in the design of these casemates is that the guns can be trained through a wide arc. This general policy is consistent with the arrangement made since the war by the Japanese authorities, who have in all cases adopted, in addition to the primary guns, a large battery of 6-inch weapons, a quality which has since become general among all naval powers. The sixteen smaller guns are placed in convenient positions on the superstructure, in order to command a high elevation.



JAPANESE BATTLE CRUISER KONGO IMMEDIATELY AFTER LAUNCHING

The vessels have the following leading dimensions: Length, 704 feet; breadth, 92 feet; draft, 27 feet 6 inches; displacement, 27,500 tons; service speed, 28 knots; maximum coal capacity, 4,000 tons; oil fuel capacity, 1,000 tons; shaft-horsepower, 70,000. The armament comprises eight 14-inch, sixteen 6-inch and sixteen smaller guns, with a considerable number of submerged broadside torpedo tubes.

It is of interest to note that the 14-inch gun has been adopted in these ships for the first time in battle cruisers, and only after extensive experiments by the Japanese naval authorities with 12-inch, 13½-inch and 14-inch guns, and due consideration of the relative advantages of still larger weapons. The eight 14-inch guns are mounted in pairs in four barbettes, two of which are located forward and two aft, all on the center line. These barbettes are arranged, and the elevation of the guns is fixed, so that four may fire forward and four aft, while all eight may fire on either broadside. The guns to the rear of the bow barbette are at a higher elevation, and in the case of the two after barbettes the forward pair are at a higher elevation, although, owing to the relative positions of the one to the other, the difference in height is not so great as in the forward guns; but, owing to the absence of any obstruction abaft the guns, it is possible

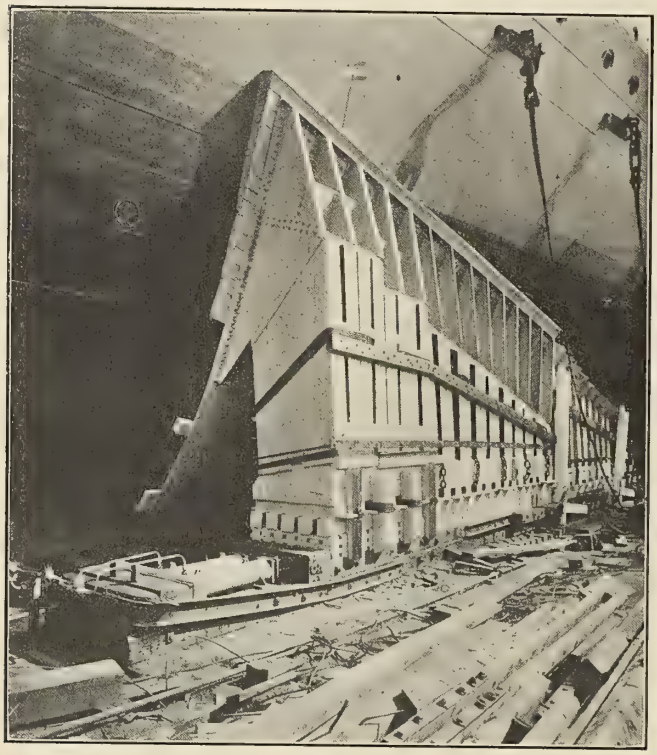
Notwithstanding the very powerful armament provided the armored protection is most effective, particularly against torpedo attack. Indeed more weight has been allotted to this than in most ships. The main broadside armor is of special quality steel, and is equal in thickness to that of any battle cruiser yet designed, and is carried to the height of the boat deck, which is continued on the same level as the forecastle, forming a gun-citadel, into which the 6-inch gun casemates are worked. The main belt extends considerably below the waterline, and under this again there is an auxiliary armor belt extending some distance below the normal armor shelf. There is a special arrangement of armored bulkheads protecting the vital parts of the ship; the magazines, for instance, being completely surrounded with special steel armor. There is an armored deck at the waterline level, and in addition to this there is an armored deck closing in the ship from stem to stern at the level of the top of the side armor.

In the case of the propelling machinery the same idea of adopting the best practice of the moment has been carried into effect; the watertube boilers burn oil fuel as well as coal; the turbines are of the combined impulse and reaction type, and in the details and in auxiliary engines several interesting improvements have been effected. To ensure safety,

the boilers are arranged in eight compartments, four on each side of a center-line bulkhead, which extends throughout their entire length, while the coal bunkers are also disposed to afford protection. Again, the engines—two sets of turbines on four shafts—are arranged in two compartments, with a center-line bulkhead between them. The condensers, four in number, are placed aft of the turbines in two separate rooms, together with centrifugal pumps and other auxiliaries.

The whole of the arrangements, including those of the steam and exhaust piping, feed, drain and oil lubrication systems, are such as to preserve the independence of the port and starboard sets of machinery, and allow either set to be worked when all parts of the other are disabled. Thus steam can be got from any of the eight boiler rooms.

Each set of turbines consists of one high-pressure and one low-pressure turbine, the former being coupled to the outer and the latter to the inner line of shafting on each side of the center line. Both the high and low-pressure astern turbines are incorporated in the after end of the same casings as the corresponding ahead turbines, and thus all four shafts are available for astern working. The working steam pressure at the engines is 205 pounds per square inch.



BOW CRADLE ON PORT SIDE

The high-pressure ahead and astern turbines are, as already indicated, of the Parsons combined impulse and reaction type, each being provided with an impulse wheel at the high-pressure end. Each impulse wheel carries a single stage of impulse blading, consisting of four rows of rotating blades with their corresponding guide vanes. The nozzles are arranged in groups, in such a way that a high initial pressure may be maintained when the turbines are working at reduced powers, as the supply of steam may be shut off from one or more of such nozzle groups. Following the impulse blading are the usual stages of reaction blades, seven in number in the case of the ahead turbine, while the astern impulse wheel is succeeded by two short stages of the reaction blading. Great care was bestowed upon the design of the blading of the impulse stages, and particularly upon the method adopted for its attachment to the rotors. With the exception of the last row of moving blades, which are of brass, these blades are of special nickel-coated mild steel, welded onto sectional foundation rings of mild steel. The foundation rings are dovetailed into grooves on the wheel rim, to which they are fixed by brass packing calked into one side of the groove. The rotor drums, spindles, connecting pieces and impulse wheels are made of forged steel; the rotor wheels are of forged steel of the arm type.

The combined high-pressure ahead and astern arrangement, together with the introduction of impulse wheels and a two-stage cruising element in one casing, necessitated the construction of a turbine of exceptionally large over-all dimensions. These features constituted a departure from the usual practice in marine turbines of high power, and it was generally found necessary to exercise great care in preparing the detail designs of the rotors and casings, so as to ensure sufficient strength and freedom from distortion under the varying steaming conditions which will obtain on service.

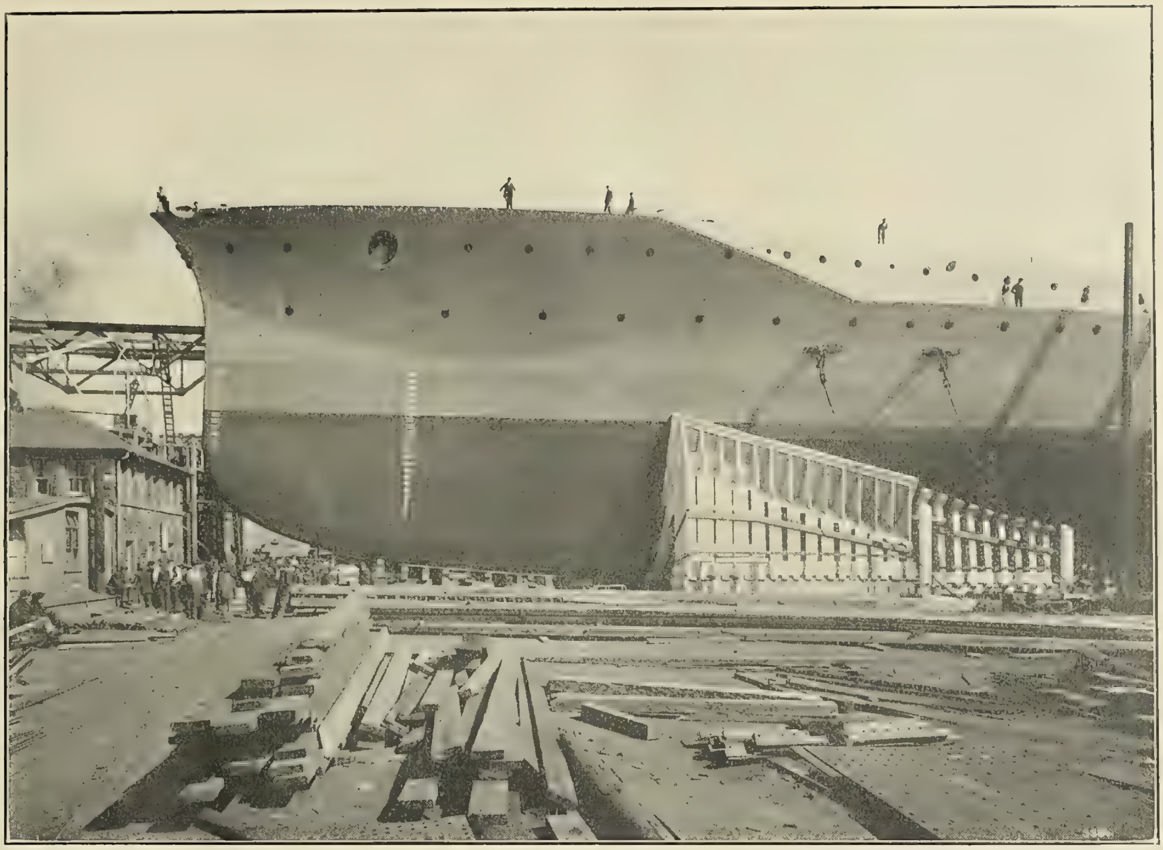
The two low-pressure turbines are on the reaction principle throughout. The object kept in view in the general design of these turbines has been the maintenance of a high economy, not only at full power but also at the lowest anticipated cruising powers under service conditions.

The turbine and propeller shafting are of forged steel, bored hollow throughout the whole length of the shaft. Thrust and adjusting bearings are fitted to each line of shafting. The screw propellers are four in number, three-bladed, the material being of manganese bronze, the blades and boss forming one casting. Complete forced lubrication arrangements are provided for the turbine and plummer-block bearings, the oil being supplied by direct-acting pumps, two of which are fitted in each of the four engine rooms. The oil is passed through coolers of the tubular type, the circulating water for which is supplied by a direct-acting pump fitted in each of the four engine rooms.

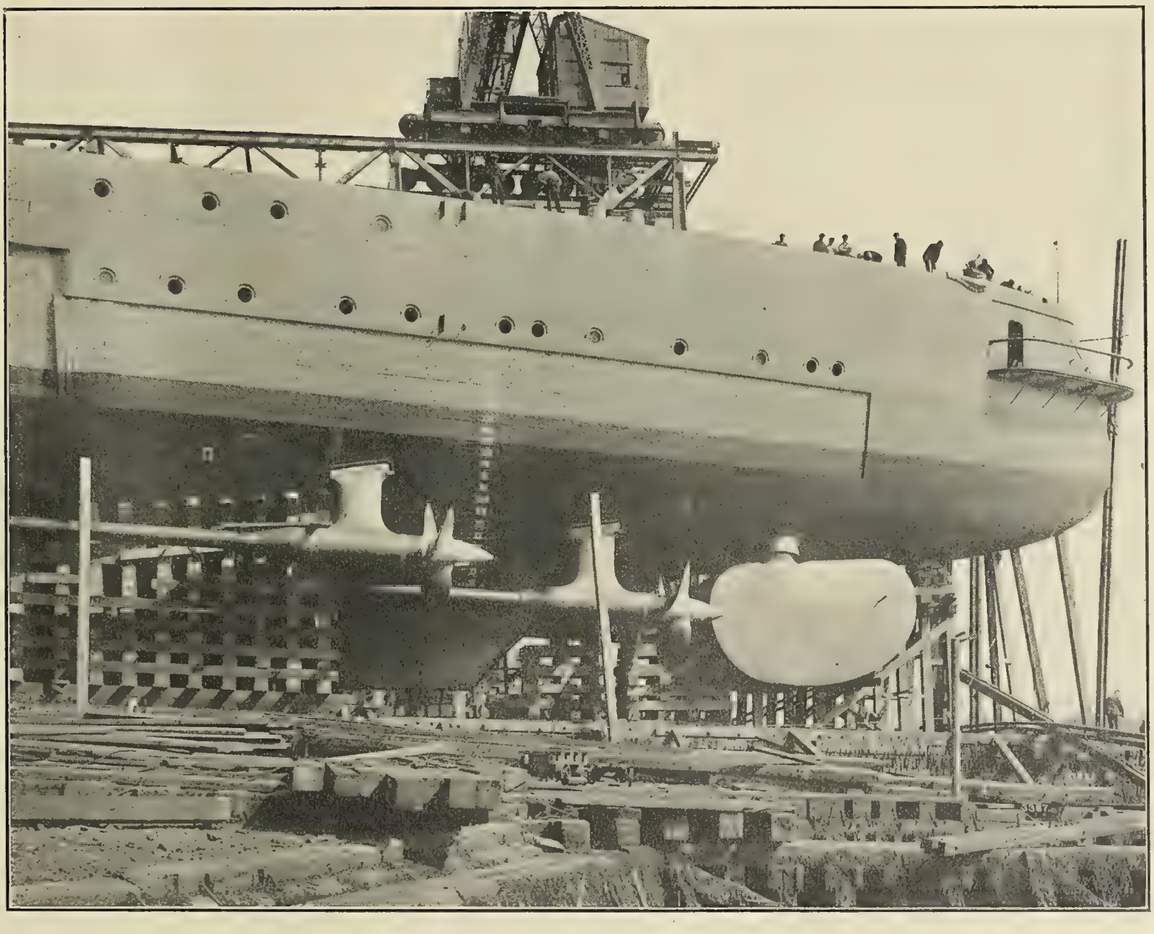
The four main condensers fitted, two in each condenser compartment, are of the Uniflux type, with the tube casings built up of steel plates and angles. The end covers are of cast iron, to protect the tubes, etc., from galvanic action. There are two independent air pumps for each pair of main condensers, the pumps being of the Dual type, each having one air and one water barrel. The circulating pumps for the main condensers are of the centrifugal type, two for each pair of main condensers. The pumps are driven by independent two-crank engines fitted with forced lubrication. Two auxiliary condensers, one in each condenser compartment, take the exhaust steam from the auxiliary machinery. In connection with the auxiliary condensers two air and two circulating pumps are provided.

In the boiler room there are eight main and eight auxiliary feed engines of the direct-acting type; the capacity of the auxiliary feed service is equal to that of the main. There are four grease extractors in connection with the delivery pipes of the main air pumps and two for the auxiliary air pump discharges. Fourteen steam pumping engines are fitted for fire and bilge purposes and for emptying the double bottoms of the compartments. Four of these pumps are fitted in the engine rooms and the remainder in the boiler compartment; those fitted in the boiler rooms are also capable of being used in connection with the See ash ejectors, ten of which are provided.

The thirty-six watertube boilers in the ship are of the Yarrow large-tube type, arranged to pass the products of combustion into three funnels. They are loaded to 275 pounds pressure per square inch, and are arranged to work under forced draft with closed stokeholds. The boilers are arranged to burn oil fuel as well as coal; a complete installation of pumps, heaters, filters and collectors, with all connections, being provided and fitted complete for this purpose. Electrical indicators for regulating the firing of the boilers are fitted



VIEW OF KONGO WITH CRADLE READY FOR LAUNCHING



VIEW OF STERN SHOWING PORT PROPELLERS AND RUDDER

complete in the boiler room, the furnaces being numbered to correspond with numbers which are periodically displayed on the indicator dials. Five steam-driven air compressors are fitted for cleaning the boiler tubes externally by air jet.

The fans for supplying forced draft to the boilers number thirty-four—thirty-two of the single-breasted and two of the double-breasted type. They are driven by double-acting steam engines fitted with forced lubrication. The six evaporators are worked with steam taken from the auxiliary steam service. The two distilling condensers are of the cylindrical type, capable of condensing all the steam from any four of the evaporators. All the evaporators are connected so that any of them can deliver their vapor either to the distiller or the auxiliary condenser in their own compartment.

While Messrs. Vickers are to be congratulated on having combined on such a comparatively small displacement the satisfactory fighting qualities enumerated alike in regard to gun power, armament, speed and radius of action, it should be remembered that the elements of design were, as we have already explained, laid down by the Japanese authorities.

The *Kongo* was launched at Messrs. Vickers' naval construction works, Barrow-in-Furness, on May 18 last, and the photographs reproduced illustrate the cruiser in various stages of construction and after being floated. Not only by reason of the design of the ship, but also because her launching weight was greater than that of any war vessel previously floated, the occasion was vested with considerable interest.

The total launching weight carried on the standing ways was 13,220 tons, with a mean pressure on the ways of only 1.98 tons per square foot. The ship, it may be noted, has a length of 704 feet and a beam of 92 feet, and the standing ways, made for the most part of pitch pine, had a length of 682 feet. The sliding ways, of oak forward and pitch pine aft, were 538 feet 6 inches long, the ship having an overhang forward of 74 feet 6 inches, owing to the very fine entry, and of 90 feet aft, due to the cut-up of the stern to suit the propellers and rudders. The keel of the ship had been laid on a declivity of 16.5/32 inch per foot, and the declivities of the standing and sliding ways, respectively, were:

Declivity of Ways (in 1/32 inch Per Foot)

	Standing Ways	Sliding Ways
At fore poppet	12.3	12.3
At center of length of standing ways	18.35	17.1
At end	24.4	21.8

The construction of the cradle, both forward and aft, is well shown in the photographs. The forward is the more interesting. The practice of securing the heads of poppets in some form of metal structure—cast, bolted up or riveted to lie snugly into the form of the ship—has been adopted for some considerable time. In this case the structure was of steel plates and angles, with web brackets for stiffening purposes. This structure was not secured in any way to the ship, but was packed up with timber between the skin plating and the main plates of the cradle. These plates extended under the keel between the port and starboard sides of the cradle. This arrangement not only obviates any possible strain on the ship's structure, but, while cradling the ship snugly, enables the cradle to fall away as soon as the ship is water-borne.

Consideration was given to ensure as wide a distribution as possible of the maximum thrust upon the ways when the stern began to float. This downward thrust was experienced when the ship was 220 feet from the end of the seaward ways. In order that the consequent pressure should be distributed over the greatest possible length, layers of soft wood (spruce) were introduced in the lower part of the packing forward. The location of this packing, and its extent relative to the total area of the sliding ways, were determined with due regard to the pressures which it was calculated would be exerted at various points forward, owing to the gradual rising of the stern. The success of this proportioning of area is established by the fact that there was not the slightest suggestion of heat or firing due to friction on the ways, as is often the case.

The use of the spruce had the further effect of cushioning the force exerted on the fore poppets when the stern became water-borne. This was of consequence, in order to obviate any excessive stress on the cradle, or indeed on the vessel itself.

In order that the extent of crushing could be ascertained, a gage was set up consisting of a wire-rope connection from the bottom of the sliding ways up to the deck of the ship, where it passed over a pulley, a weight and recording disk being arranged. By this means it was ascertained that the maximum extent of crushing was 6 inches, which was at the forward end of the cradle. An examination of the spruce afterwards recovered from the water showed that the permanent compression of the material was only 1 inch.

In order to indicate on the launching platform the rise of the tide, not only on the launching ways but at the Ramsden dock, through which the vessel had to pass to the fitting-out berth, there was applied the Gardner-Ferguson patent electric transmitter, which indicated on a dial on the launching platform the rise of the tide in inches at both points by means of electric apparatus actuated by floats. Thus those in charge of the arrangements were able to ascertain when the launch could take place, which was within three seconds of the anticipated time.

The method of releasing the ship followed the practice established by experience. There were two pairs of dog-shores, and in addition three pairs of triggers held in position by hydraulic rams; the releasing of the water in the cylinders enabled the rams to recede and the triggers fell from the vertical to the horizontal position, thereby unlocking the sliding ways. Two rams were placed under the stem to assist in the taking out of the keel blocks. Four rams were located at the head of the standing ways in order that, if necessary, the sliding ways could be given an impulse. This, however, was found unnecessary. The ship began to move as soon as the hydraulic triggers were released, and the time taken for the first foot of travel was thirteen seconds, and for the remaining 681 feet forty-five seconds. The maximum velocity was 25½ feet per second, equal to 15 knots, and this was when the vessel had traveled through 500 feet.

There was used a simple method of recording the speed at various points. The instrument used consists of a drum 10 feet in circumference, carrying 3/16-inch log wire 1,200 feet long, the drum being capable of taking the whole length in one lap. This drum is mounted by nuts on a screwed spindle, fixed in bearings on standards with set-pins. As the wire pays out the drum rotates on the screwed spindle at a speed exactly corresponding to that of the ship, and at the same time the drum travels axially along the screwed spindle. For record purposes there is attached to the winding drum a cylinder carrying the recording paper. The diameter of the cylinder is arranged directly proportionately to the diameter of the paying-out drum, so that one revolution of the recording cylinder represents a given length of travel of the ship. The instrument is fitted with an electric chronometer, marking on the paper every half second of time, while a pencil records the rate of travel of the cylinder. To control the rotation of the drum there is fitted outside of the nut connection to the screw a brake, to ensure that the wire is always taut. This instrument gives the speed throughout the whole of the travel of the ship.

To bring the ship up when afloat, chain drags were used,

there being six sets on each side of the ship, each composed on an average of about 20 tons, the total weight of drags being 740 tons. The drags began to take effect after the ship had left the ways 10 feet, and from this point until the ship was brought to rest the vessel traveled 220 feet. There were also two stern anchors in order to assist in swinging the ship into line with Walney Channel. The strong tide running, owing to the direction of the wind, caused the ship to swing quickly. She was ultimately taken in charge by tugs and safely moored under the 150-ton crane at the Buccleuch Dock, where she will be fitted out.

It may be added that the vessel had, before launching, all her boilers on board, as well as all the auxiliary machinery, the only exception being the main turbines and the four condensers. A considerable amount of the armor, nearly one-fourth of it, has been fitted on board, and the location of the armor was determined in order to give an even keel when afloat.

Results of Experiments with a Watertube Boiler, with Special Reference to Superheating*

BY HAROLD E. YARROW

The objections which have hitherto been raised to superheating for marine work are:

(1) Owing to the dryness of the steam, oil for the internal lubrication in recoprocating engines becomes a necessity, and the oil, finding its way into the boiler, leads to trouble.

(2) The probability of burning the superheater when the passage of the steam through it is suddenly reduced or stopped.

By the introduction of turbines the difficulty of lubrication does not occur, and with regard to burning the superheater tubes the arrangement we adopt avoids this risk.

The boiler with which these tests were made was of the Yarrow type, and was fitted up in our experimental shop, which is equipped with the necessary plant for making very complete tests. Throughout the experiments oil fuel only was used, and as it is possible with oil to maintain steady and uniform working conditions, very accurate results were obtained, which would not have been possible with coal, in which case irregularity of stoking and other sources of discrepancy occur. During the experiments careful records were taken of the oil consumed, the water evaporated, steam pressure, temperature of the superheated steam, and the temperature of the gases at various points during their passage past the boiler tubes.

As is well known, superheating is very largely adopted in land installations, and in locomotives it is being rapidly introduced. From information kindly given us by the locomotive superintendents of the main railway lines in this country, it appears that the economy realized in locomotives due to superheating averages fully 20 percent in fuel consumption, and rather more in water consumption. It may perhaps surprise many marine engineers to know that on the Great Western Railway alone no fewer than 500 locomotives are now running fitted with superheaters. Taking the average of several land turbine installations, there is found by superheating to 100 degrees F. to be a saving in consumption of fuel of from 8 to 10 percent, and in steam consumption from 10 to 12 percent. The reduction in steam consumption is specially important for marine work, as it enables a reduction to be made in the size and weight of the condensers, air pumps, circulating pumps and feed pumps, and probably of the distilling plant. Independent of the gain directly due to superheating, the risk of water passing into the turbine from any cause whatever is reduced, and the fear of damage in consequence of water causing the stripping or cutting of the blades is diminished, and any additional cost of up-keep of the superheater will doubtless be fully balanced by the diminished risk of injury to the turbine blades by the action of water when using saturated steam.

Turning now to the design of the boiler and superheater with which the various experiments were carried out, I beg reference to Fig. 1, which shows a cross section of the boiler, and it will be seen that it consists of a top steam collector, as usual, and two lower water pockets. On the left-hand side the superheater is shown, and it will be observed that on this side of the boiler there are fewer rows of generator tubes than on the other side, where there is no superheater, it being thought desirable that the total heating surface and the resistance to the gases on both sides of the boiler should be approximately the same. The total heating surface of the boiler was 6,700 square feet, of which 1,265 square feet consisted of superheating surface; the total heating surface on the superheater side of the boiler was 3,453 square feet, and on the other side 3,247 square feet.

The superheater consisted of a number of "U" tubes expanded into two longitudinal collectors, small doors being fitted so that access could be obtained to the tubes when required. The leading feature of the arrangement is that the superheater is placed on one side of the boiler only, and a damper is fitted in the up-take on the same side, as shown on the diagram. If this damper is closed the whole of the gases are deflected towards the opposite side of the boiler, and no heated gases pass the superheater, the object being that if the main engines should be suddenly eased or stopped, or when raising steam, the superheater may be shut off, so as to prevent the tubes being damaged, or the steam being superheated to an excessive extent, owing to there not being sufficient circulation of steam. In this way one objection to the introduction of superheating for marine installations is overcome.

A further advantage of this arrangement is that when the consumption of steam is suddenly reduced or stopped, not only does the damper prevent the superheater tubes from being burnt, but it also greatly diminishes the output of the boiler at the time when a reduced supply of steam is wanted, because only about one-half of the heating surface comes into contact with the hot gases. To avoid the possibility of the damper getting distorted through over-heating, it is provided with a hollow spindle, to which air is admitted, and which passes from thence between the two plates of the damper, escaping at the edge, and thus keeping the damper cool. This arrangement of damper has proved thoroughly successful under the most trying conditions.

In order to carefully measure the temperature of the superheated steam and of the gases, a complete installation of thermometers and pyrometers was fitted to the boiler, and

* Read before the Institution of Naval Architects, March, 1912.

TABLE A

Trials with Damper Open

Heating surface { Large Nest of Generator Tubes = 3,247 square feet; Small Nest of Generator Tubes = 2,188 square feet; Superheater = 1,265 square feet } 6,700 square feet total.

On these trials the heating surface is taken as the total heating surface of 6,700 square feet.

Steam Pressure Pounds per Square Inch.	Superheat in Degrees Fahrenheit.	Air Pressure, Inches of Water.	Pounds of Water Evaporated per Hour.	Pounds of Oil Fuel Burnt per Hour.	From and at 212 Degrees Fahrenheit. Pounds of Water Evaporated per Pound of Oil per Hour.	From and at 212 Degrees Fahrenheit. Pounds of Water Evaporated per Square Foot of Heating Surface per Hour.	Pounds of Oil Fuel Burnt per Square Foot of Heating Surface per Hour.	Temperature of Feed Water, Degrees Fahrenheit.	Temperature Between Small Nests of Generator Tubes and Superheater, Degrees Fahrenheit.	Temperature of Uptake, Degrees Fahrenheit. Above Superheater.	Temperature of Uptake, Degrees Fahrenheit. Above Large Nest of Generator Tubes.
242.	93.5	5.0	94,659	8,286	14.6	18.0	1.237	58.0	1,121	828	887
243.	93.0	3.16	76,021	6,454	15.0	14.4	.9635	63.5	926	698	727
243.7	82.5	2.44	68,387	5,695	15.2	12.9	.850	63.5	903	685	688
242.8	61.1	1.7	46,041	3,630	15.9	8.6	.542	64.0	647	536	551
241.8	31.0	.998	20,059	1,540	16.1	3.7	.230	62.2	481	432	448
242.2	20.75	.625	8,478	649	16.1	1.55	.096	63.5	465	409	416

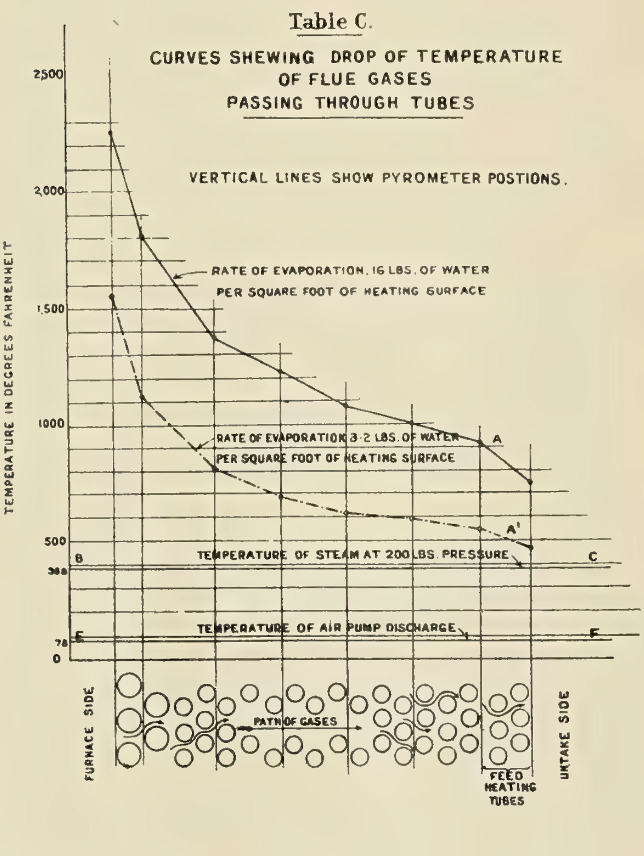
TABLE B

Trials with Damper Shut

Heating surface { Large Nest of Generator Tubes = 3,247 square feet; Small Nest of Generator Tubes = 2,188 square feet; Superheater = 1,265 square feet } 6,700 square feet total.

On these trials the heating surface of boiler is taken as heating surface of Large Nest of Generator Tubes = 3,247 square feet.

Steam Pressure, Pounds per Square Inch.	Air Pressure, Inches of Water.	Pounds of Water Evaporated per Hour.	Pounds of Oil Fuel Burnt per Hour.	From and at 212 Degrees Fahrenheit. Pounds of Water Evaporated per Pound of Oil per Hour.	From and at 212 Degrees Fahrenheit. Pounds of Water Evaporated per Square Foot of Heating Surface per Hour.	Pounds of Oil Fuel Burnt per Square Foot of Heating Surface per Hour.	Temperature of Feed Water, Degrees Fahrenheit.	Temperature of Uptakes, Degrees Fahrenheit above Large Nest of Generator Tubes.
242.0	4.85	68,648	6,287	13.25	25.66	1.936	61.0	913
242.25	3.97	57,693	5,065	13.84	21.6	1.56	60.0	843
242.4	2.491	44,050	3,504	15.3	16.5	1.09	60.3	673
242.5	1.46	31,481	2,473	15.4	11.75	.76	63.5	603



we have to thank the director of the National Physical Laboratory, Dr. Glazebrook, and also Dr. Harker, for the assistance which they kindly afforded us in the selection of the most reliable instruments for this purpose.

Turning to Table A, giving particulars of one series of the trials with the damper open, it will be seen that the results are given for six rates of evaporation. It will be observed that at the maximum rate of evaporation, namely, when burning 1.237 pounds of oil per square foot of heating surface per hour, the degree of superheat was 93 degrees F. Corresponding figures are given at the lower rates of evaporation.

We now pass to similar trials with the damper closed, and on these the heating surface of the boiler is assumed to be that of the large nest of generator tubes only, as all the gases have to pass on that side of the boiler. The results of this series are shown on Table B.

As one of the objects of the marine engineer is to obtain more and more steam out of a given weight of boiler, we thought it would give useful information to make tests burning oil fuel at a rate of consumption considerably greater than has hitherto been the custom, to ascertain if the boiler would, under such conditions, show any defects. It will be seen from Table B that at the highest rates of evaporation nearly 2 pounds of oil per square foot of heating surface per hour were being consumed, if we disregard the heating surface on the superheater side of the boiler. Thus the surface on the opposite side of the superheater was subject to the heating effect of all the gases plus half the radiation. Every part of the boiler withstood the severe test, and trials burning this quantity of fuel were made on several occasions.

The results of other experiments indicate that in a properly designed boiler of the type we are dealing with, it is possible

to burn, without injury to the boiler, 2 pounds of oil per square foot of heating surface per hour.

Since these experiments were carried out the official trials have taken place with one of the destroyers built by us for the British Admiralty, H. M. S. *Archer,* in which boilers fitted with superheaters were provided. The result of these trials showed that the gain we expected was fully realized, and on the full-speed trial the degree of superheat at the turbines was 94 degrees F.; the shaft-horsepower developed was slightly over 18,500, which compares with about 17,000, which is the shaft-horsepower we should have expected had the boilers been of the usual type. The mean speed obtained on the six runs on the measured mile at Skelmorlie was 30.9 knots, and the mean speed for eight hours 30.3 knots, the contract speed being 28 knots.

One point to which Mr. Charles Merz (to whom I am greatly indebted for much valuable information) has drawn attention is the necessity, with the use of superheated steam, of efficiently covering the high-pressure portions of the turbine cylinder with non-conducting material, because the

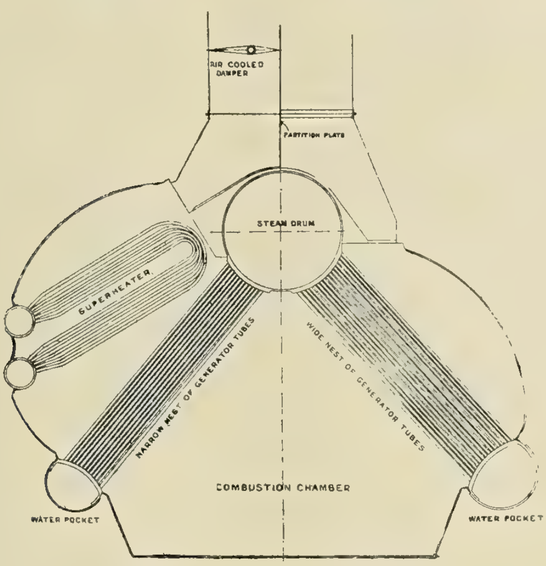


FIG. 1

metal on the inside of the cylinder in contact with the steam becomes hotter than that on the outside, especially at the edges of flanges and ribs. The inside tends to expand, and this expansion is resisted by the colder metal on the outside; consequently, if the temperature difference is great enough, the metal will be distorted, and perhaps strained beyond its elastic limit. For this reason the design of the ribs should be carefully considered, the thickness of metal throughout the structure being kept as uniform as possible.

These experiments were also the means of pointing out to us another important improvement in the Yarrow boiler, and Fig. 2 has been prepared, which illustrates the ordinary type of boiler without superheater, from which it will be seen that the last two rows of tubes farthest from the fire are partitioned off for the feed water to ascend. When working the boiler *at high rates of evaporation* we found that notwithstanding all possible precautions, even with turned rivets and carefully reamered holes, we were unable to prevent the riveted seam of the water pockets from leaking. We found the pocket was sometimes hot and sometimes cool; indeed, in places sufficiently cool to be able to bear one's hand on it. These trials were frequently repeated with the same result, and we ultimately found out the cause. The fact was that the suction down the tubes which were in close proximity to the feed-heating tubes was so great that the cool feed water which had passed up the feed-heating tubes was instantly drawn down into the water pocket without having had time to mix with the hotter water in the upper chamber, as indicated by the arrow in Fig. 2. This action took place intermittently, and the water pockets locally changed their temperature, one portion of the water pocket being one minute hot and another minute comparatively cool, dependent upon the working of the feed pump. The strain thus thrown on

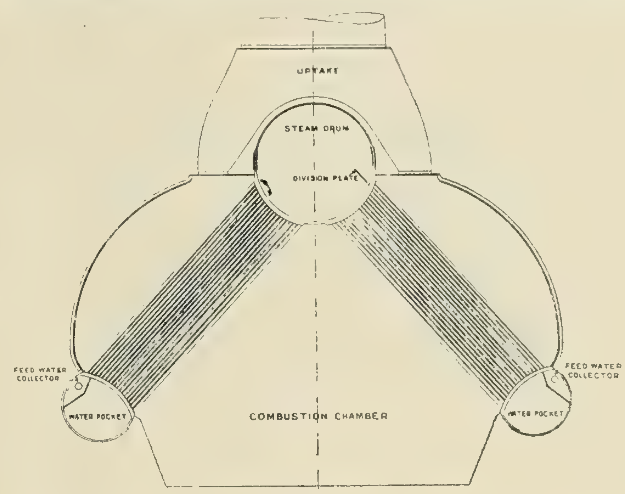


FIG. 2

the metal of the water pockets by this short-circuiting of the feed was evidently severe, and resulted in the leakage of the seams. Having discovered the cause of our trouble it was not difficult to find a remedy. It was found that by simply placing a longitudinal partition plate in the upper chamber, so as to avoid the short-circuiting of the feed, all difficulties disappeared. This plate is shown on the right-hand side of the diagram only, but in practice it would, of course, be fitted

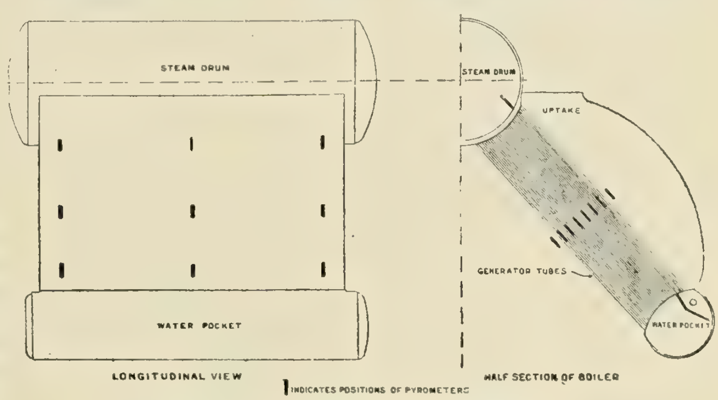


FIG. 3.—SHOWING POSITIONS OF PYROMETERS

on both sides. The same trouble has before been met with, especially abroad, but the true cause was never suspected; it was generally put down to inferior workmanship. Even when no trouble is experienced, it is evident that serious and undesirable strains must at times be taking place, which may in the end lead to the failure of the metal, due to constant fatigue. By the fitting of this partition plate, however, all such strains are eliminated.

Fig. 3 has been prepared to show the positions of the pyrometers.

Table C shows the temperature of the gases at various points in the boiler. The vertical lines correspond to the position of the pyrometers, as shown in Fig. 3. The upper curve indicates the gas temperatures at a rate of evaporation of 16 pounds of water per square foot of heating surface, and the lower curve represents the gas temperatures at a rate of evaporation of slightly over 3 pounds per square foot of

heating surface. The horizontal lines represent temperatures, and the line *B C* represents the temperature of the steam at 200 pounds pressure, and the line *E F* the temperature of the air pump discharge taken at 78 degrees F.

It will be observed, the very great drop in temperature which takes place during the passage of the gases through the first rows of tubes, showing the large proportion of heat that

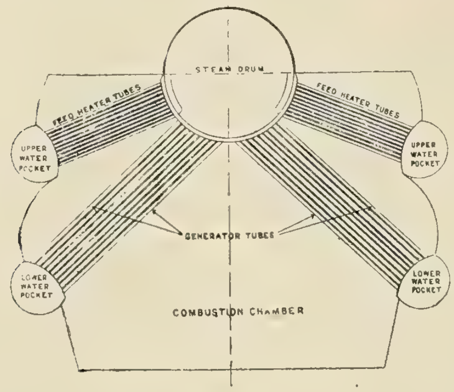


FIG. 4

is taken out of the gases by these tubes. Also it will be observed, that there is a sudden drop in the temperature at *A* and *A'*; that is, where the gases pass through the last rows of tubes. This is due to the fact that the cold feed water (which enters a portion of the water pocket) abstracts a greater amount of heat from the gases in ascending the two outside rows of tubes than would be the case if these tubes were full of water at the temperature of the steam.

Referring to Table C, given in diagram form, it will be seen that the temperature of the gases at the point *A'*, *i. e.*, just prior to the gases passing the feed-heating tubes, is about 550 degrees F., and the temperature of the steam at 200 pounds pressure is 388 degrees F., a difference of only 162 degrees, whereas the temperature of the air pump discharge of 78

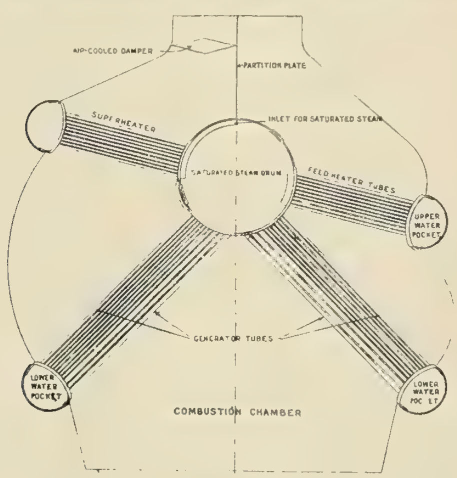


FIG. 5

degrees F. gives a difference of 472 degrees. This clearly shows the gain due to this system of feed heating, and the desirability of extending it, which can be effected by having separate water collectors and feed-heating tubes apart from the main water collectors and main generator tubes, *i. e.*, there would be two water collectors on each side of the boiler, the tubes connected to the top one acting as a feed heater, and such a design of boiler is shown (Fig. 4).

It should also be pointed out that there is a supplementary and an important advantage in this feed-heating, namely, that any grease or sediment that comes over with the feed is deposited in these tubes, which are not subject to fierce heat, rather than in those nearer the fire, which are exposed to the intense radiation of the furnace, and thus the life of the boiler is prolonged. With the introduction of oil fuel some such arrangement is the more necessary, because it has been

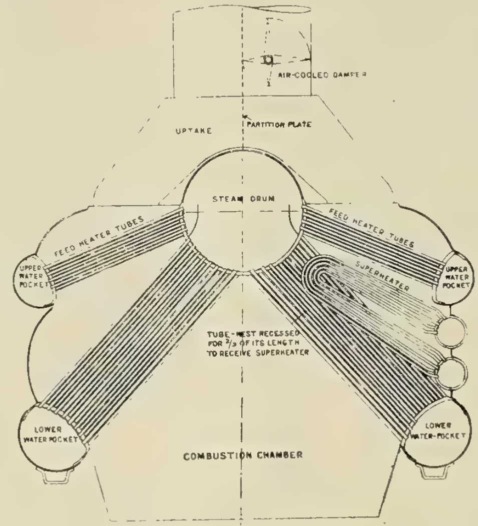


FIG. 6

found that the oil heaters leak, with the result that oil mixes with the steam and passes ultimately into the boiler.

As I thought it would interest the meeting to indicate some of the arrangements for superheating and feed heating which may be adopted with a view to still further improving the results in connection with such a boiler as the one we are dealing with, I beg your reference to three illustrations.

Fig. 5, it will be seen, shows the superheating tubes united to the steam drum, and to a steam receiver sufficiently large for a man to enter, the tubes being expanded at both ends.

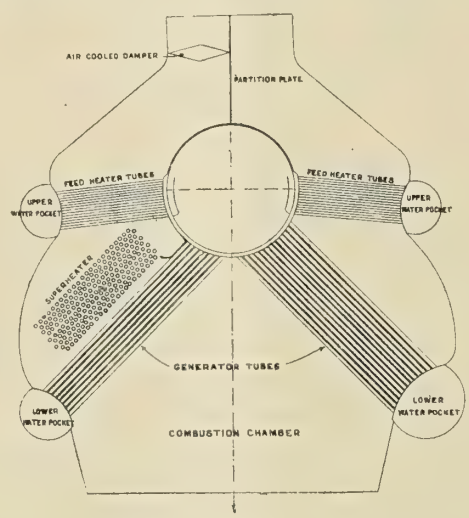


FIG. 7

In this arrangement all the tubes are straight, a condition much appreciated by many authorities, and also there is an additional advantage by this system, as the superheating tubes on the one side of the boiler and the feed-heating tubes on the other side of the boiler are of such a length that they can be withdrawn and replaced from inside the steam drum.

Fig. 6 shows a set of U-shaped tubes placed between the generator tubes and the nest of feed-heating tubes, the nest of generator tubes being recessed for about two-thirds of its length to receive the superheater. The ends of the superheater tubes are expanded into two longitudinal steam re-

ceivers. This arrangement will probably be the most efficient for a given quantity of heating surface.

Fig. 7 shows the superheater tubes placed at right angles to the generator tubes. This arrangement has the advantage that all the tubes are straight. I would mention that the arrangement of running the tubes at right angles to the generator tubes has already been adopted in boilers of certain warships constructed by Messrs. John Brown, and also by ourselves, with the exception that a superheater was fitted on both sides of the boiler, and was, therefore, not under the same control as in the case of the superheater fitted only on one side in conjunction with a damper.

It is proposed in some cases to have an additional damper on the opposite side to the superheater, the two dampers being arranged so that either can be open, or both open, but under no condition can both be closed. This enables the superheater side of the boiler to be used to a greater or less extent as desired. When cruising at a slow speed this arrangement may possibly lead to a more economical result than if both sides of the boiler are equally free for the passage of the hot gases.

Judging by the best practice in land installations, 100 degrees F. superheat is by no means the limit that can be adopted with advantage. It is reasonable to suppose that the requisite condition to be desired is that the steam should remain in gaseous form as far as possible during its passage through the turbine, because any condensation that takes place must diminish the energy given out by the steam to the blades of the turbine, also while the steam remains in gaseous form the steam friction is reduced.

I would submit, from the results of the accumulated experience of others, and from our own experiments, that there will be a certain gain by the use of superheated steam of from 8 to 10 percent in fuel economy when using 100 degrees F. of superheat, and from 11 to 13 percent gain when using 150 degrees F. of superheat in combination with a pressure of 200 pounds per square inch.

Also, a further gain in fuel economy can be obtained by an efficient system of heating the feed from the gases after they have passed the generator tubes, so that some of the remaining heat should be absorbed which would otherwise be lost.

Although the experiments were made with an oil-burning boiler, the various arrangements as shown in the diagrams would be equally suitable if coal were used, and there is no reason to suppose that similar advantages could not be obtained.

With regard to the relative weights of boilers, with and without superheaters, provided the total heating surface were the same, there would be no appreciable difference. If, however, the complete machinery installation is taken into account, there would probably be a small saving in weight in the case of the installation with superheated steam. I would therefore submit that in the propelling machinery of warships improved results can be obtained by superheating, without increased weight, cost, space or up-keep, and a further extension of feed heating by the waste gases.

It may be of interest for me to describe a further experiment which has been made bearing on the value of superheating.

Referring to Fig. 1, an additional damper was fitted on the side opposite to the superheater, and on a vessel a trial was made during a given time with the damper on the superheater side open and the other damper closed, so that all the gases would have to pass by the superheater. On this trial a speed of 15 knots was obtained, the degree of superheating being limited to 100 degrees F.

Another trial was then made of the same duration, burning the same amount of oil, and in every respect similar, but with the damper on the superheater side closed and the other damper open, thus only using saturated steam, and it was found that the speed at once dropped from 15 to 13 knots.

This clearly proves the gain due to superheating, which enables the cruising speed to be raised from 13 to 15 knots with the same consumption of fuel, or a corresponding increase in radius of action at 13 knots. These are results which have been actually obtained, and which we are prepared to repeat.

Commercial Motorboats Gaining Favor

The *Captain Collier,* illustrated herewith, shows how the gasoline (petrol) engine is taking its place in shipping and freighting work. Owing to the low first cost, low maintenance cost and the great economy in intermittent service, the slow-speed heavy-duty gasoline (petrol) engine offers exceptional advantages in boats built for or adapted to this kind of service to-day. And this is especially so where the lower and cheaper grades of gasoline (petrol) are used as fuel.

The *Captain Collier* was completed several months ago by the Cramp Ship Building Company, Philadelphia, Pa., for the Guffey Petroleum Company, and has been used in continuous service since. She is 109 feet long, 22 feet beam and 7½ feet draft. She has eight 8,000-gallon tanks, having a collective

THE CAPTAIN COLLIER, A MOTOR TANK BOAT

capacity of 64,000 gallons. Besides having room for a large deck load, she has storage space in the forward hold for the carrying of 100 barrels, the vessel being equipped with derrick and power hoist for the handling of barrels and case goods cargo.

The power plant consists of two 90-100 horsepower Standard gasoline (petrol) engines, which give the vessel a speed of 8½ miles per hour. She is also equipped with a Standard 4½ kilowatt dynamo directly connected with the Standard auxiliary engine, with air pump and bilge pump attached. The boat is electrically lighted and very completely equipped.

As can be seen from the picture, she is a thoroughly wholesome type of vessel. So well do her owners look upon her work that they are now building a new vessel 150 feet long to be equipped with a single 300-horsepower, reversing-type Standard engine and auxiliaries. This vessel is building at the Skinner Ship Building Yard, Baltimore, Md.

H. M. S. Firedrake, one of the three special destroyers ordered by the Admiralty last year from Messrs. Yarrow & Company, of Glasgow, completed her official full-speed trials June 29, on the Skelmorlie course, attaining during a continuous run of eight hours a mean speed of 33.17 knots, thus exceeding the contract speed of 32 knots by 1.17 knots. The vessel is 255 feet long by 25 feet 7 inches beam, and is propelled by Parsons turbines driving two shafts, steam being supplied by three Yarrow watertube boilers fitted with the firm's latest feed-heating devices.

Common Sense in Engineering*

BY WALTER M. McFARLAND

From the very nature of things, education in our academies and schools is largely a matter of books, calculations and drawings, and while an enormous amount of valuable information and training is obtained in this way there is one absolutely vital element to success which may be, and often is, entirely neglected. This element is what we generally call common sense, but experience goes to show that it is very far indeed from being common. What we really mean by common sense is sound judgment, or the application of our knowledge and experience in an intelligent way to problems which we have to solve. It cannot be learned from books directly, and to a certain extent it is a natural gift, but there is no question that with care and attention it may be developed. I have already remarked that it is a vital element of success, and I may add that some of the most brilliant engineers whom I have known have spoken of it as more important than all their skill in mathematics, physics or any of the other sciences.

In the law schools it is now quite common to give instruction by what is known as the "case system," instead of by laying down abstract principles. That is to say, a specific case is taken up and studied and the principles developed from it, the impression being very much more lasting than a discussion of abstract principles without a specific application. In this way I am going to call attention to some very interesting cases of the application of common sense, and also to others where this was entirely lacking, which I hope will teach a useful lesson.

Going away back to the very beginning of the steam engine we find that in the earliest engines a shower of cold water was injected into the cylinder to condense the steam, and the atmospheric pressure on the other side caused the movement of the piston. As we can now see, this meant a horrible waste of steam, because, when steam was first admitted an enormous amount would be condensed against the cold piston and cylinder walls before the piston had reached the top. One of the first things that James Watt did was to remove this cause of waste by inventing the separate condenser. This seems now to have been perfectly obvious, but it took genius, in the form of common sense, to change the practice of many years.

His engines were arranged to use steam expansively, but the pressure was low and the possible range of expansion small. As steam pressures increased some enthusiasts, looking on steam as a perfect gas and forgetting that if it was so readily condensible in one vessel it would be in another, and figuring on great economies from high ratios of expansion, advocated that engines should be designed on this principle. Admiral Isherwood, who was one of the most famous experimenters in marine engineering during the latter half of the last century, had already noticed the discrepancy between the theoretical and actual steam consumption, which his investigations indicated to be due to cylinder condensation. With strong common sense he carried out a series of experiments in 1859 on the steamer *Michigan*, and demonstrated conclusively that with low pressures and slow-running engines a very moderate degree of expansion gave the greatest economy.

During the Civil War Admiral Isherwood was engineer-in-chief of the navy, and designed a very large number of highly successful engines based upon his experiments on the *Michigan*. Some of the advocates of high ratios of expansion could not be convinced by these experiments and persuaded the Department to let them put in engines of their own designs. In every case these were failures, and of a very abject kind.

Another notable illustration of Isherwood's strong common sense was the machinery of the *Wampanoag*. At the time of her trial, 1868, and for more than a decade afterwards, her speed formed the record—nearly 18 knots. While she would now be considered a small vessel of moderate power, at that time she was a large one and with high power. Isherwood felt sure that direct-connected engines of such power in a wooden hull would not give satisfaction, and, accordingly, he used geared engines to increase the speed of the propeller above that of the engine. This was absolutely a matter of common sense and experienced judgment, and the result justified his decision.

More than twenty years afterwards, Admiral Melville, when engineer-in-chief, faced the problem of putting more than 20,000 horsepower in the hulls of the *Columbia* and *Minneapolis*. At that time, 1891, no shafts had ever been built in this country to transmit more than 10,000 horsepower. As vessels with more than two screws had been used earlier with satisfactory results, he decided to fit three screws to these vessels. The reason for doing so, however, was not in anticipation of getting increased speed but solely in order to keep the shafts of a size where it was known that they would be absolutely reliable. As you doubtless know, these vessels were a remarkable success and attained speeds of about 23 knots, which at that time and for some years was faster than any other large vessels, either in the navies or the merchant service throughout the world.

One of Admiral Melville's distinguished characteristics was his splendid common sense. He was one of the most courageous men who ever lived, and like most of such men had the fine qualities of being able to undertake great responsibility and not worry about his decisions after he had reached them. He displayed his common sense in his handling of the introduction of watertube boilers for large vessels in the navy. He believed that watertube boilers would be absolutely necessary on such vessels, in order to meet the demand for large powers in limited space and weight. The torpedo boat boilers, with small, thin tubes, were not sufficiently robust to promise the longevity demanded for the boilers of large vessels. After preliminary tests he made an installation in the monitor *Monterey*. A man who was simply working for newspaper approval would have followed this up by introducing watertube boilers in every new ship; but his common sense told him that it was necessary to wait until there had been time to test the boilers out in actual service. The result was that it was about three years after the *Monterey's* boilers were given their contract trial before he placed an order for other watertube boilers. In the meantime he had concluded that the ones which were installed on the *Monterey* were not the best adapted to navy service, and by feeling his way he decided upon a boiler about which he says in his last published article: "Believing that I had found the boiler best adapted to use on our large war vessels, and confirmed in this view by their performance in service, I continued to install them as long as I remained engineer-in-chief, and my successors have done the same." Meanwhile, in some other navies which made their first installation after Melville had made

*Abstract of an address delivered at the graduating exercises of Webbs Academy, New York, June, 1912.

his, they pushed the matter, with the result that there was much dissatisfaction and great expenses.

When the first vessels of our new navy came out, a form of air pump was used where two water and air cylinders were driven from the crankshaft of a compound engine whose cylinders were fitted with valves arranged, as usual, to cut off about three-quarters stroke. It did not occur to anybody at the time that the work to be done was quite different from that of an ordinary engine, inasmuch as the work at the beginning of the air pump stroke was very little at the time when the steam cylinder was doing its most, and the maximum work of the air pump came at the end of the stroke, when the pressure in the steam cylinder was the least. These pumps and engines gave a great deal of trouble, and had to be run at a very high speed to keep them from stopping. All the designers in the different shipyards tried different methods of remedying the trouble, and finally Capt. Frank Bailey, the chief designer of the Bureau of Steam Engineering, then a passed assistant engineer, applied common sense to the problem. Some of the direct-driven air pumps had been brought out, and they could run at a very low number of strokes without any trouble about stopping. He analyzed their design and was struck by this fact: Their steam ports were only about 3 percent of the area of the piston, while the steam ports in the engines giving the trouble were about 10 percent of the piston area; also, in the direct-driven pumps the valve gear opened the port wide and kept it so until time to close it at the end of the stroke, while in the engine the valve opened slowly to full width and at once began to close. In other words, in the direct-driven pump the port was so small that the pump could not run away, and yet, if the air cylinders were flooded and the pump tended to slow down, the port being wide open permitted the full pressure to come on the piston. Accordingly, Capt. Bailey redesigned the valve gear so that the steam would follow full stroke and also reduced the area of the ports to about 3 percent. When this change was made the old engine-driven pumps worked as nicely as anybody would wish, as I can testify from personal experience after a cruise with them. As you will see from this story there was no high science or thermodynamics in this, but the application of good common sense to a difficult problem.

As bearing on this question, I want to emphasize the importance of careful observation and of checking up observations at the time they are made, so as to be sure of their accuracy. If the data are accurate they can be worked up at any time by anybody, but very often there is no other chance to get them accurately than at the particular time they are taken, which makes it of the greatest importance that their accuracy should be assured. Frequently there are very simple checks which enable this to be done. For example, in a test of a steam boiler which is intended to be run uniformly for 24 hours or more the hourly figures should not differ greatly. Two of the most important points are the amount of water fed to the boiler and the amount of coal burned. It is quite common to lay out a diagram where the ordinates for each hour will represent the total amount of coal and of water up to that time. If the amount used each hour is constant the curve joining these points would be a straight line. Now if, at the end of any hour, when the point is put down and the curve extended, it is found that there is a marked deviation, there would be a chance to hunt for the trouble, and either correct the figures if they are wrong or see what, if anything, has occurred in the conditions.

Another case illustrates in a simple way the exercise of common sense and may be worth telling. Years ago, in the navy, eccentric straps were always made of brass, and most naval men were familiar with that practice only. In the merchant service, however, the practice had already come into vogue of making the strap of cast steel, or even cast iron, and lining it with white metal to make the rubbing surface softer than the eccentric itself. The eccentric strap of a steam launch engine broke, and the young officer who had charge of that work tried to repair it by taking a couple of pieces of sheet brass of the proper thickness and riveting them together and then bending them over to make a lug for bolting to the other half of the strap. As might be expected, however, as soon as any load came on this it broke at the bend. Another young officer on this ship happened to know of the merchant service practice, and he made the repair by having the blacksmith take a piece of half-inch square bar-iron and forge it to the proper shape, and then used one of these pieces of brass as a liner. This gave entire satisfaction. The point to be noted is that he was not able to copy the exact apparatus of the merchant service, but he had grasped the general principle, which was that the body of the strap should be of a material to give strength, with a facing of a softer metal.

The Draftsman in Shipbuilding*

BY S. C. JENKINS

The building of ships is probably the most interesting and complex of any branch of engineering. There is no living man who understands in detail all the professions which enter into the design, construction and operation of a modern battleship or merchant vessel. Some men who hold high positions in the shipbuilding world may think this a bold statement, but it is true. Because of this fact we have naval architects, marine engineers, electrical engineers, navigators, etc., each specializing in his branch of the profession.

When America's ships were the peers of any afloat—that is, before the Civil War—the draftsman was unknown so far as ships were concerned. It is true that the steam engine had made its appearance by then, and that draftsmen were necessary for that branch of engineering, but they were probably known as mechanical engineers, though their knowledge was far more limited than the draftsman's knowledge of the present day. The ships of that day were built by the men who afterward manned them; were rigged by their captains, mates and sailors. Even at this day you can see this method of building certain types of ships in old New England towns where draftsmen are not needed or desired.

Before 1890, the problems of ship construction were far less complicated than at the present day. The foreman of each department worked out his problems after the skeleton ship was framed up; but in those days the requirements of the owners did not include the multitude of mechanical and electrical innovations which were then untried and barely known, and interferences were overcome by ripping out work and rearranging it to clear. The elements of time and cost were secondary. The whole scheme was crude as we see it now, but in spite of all this the results show evidence of capable work. Shipbuilding was then an art and the ship carpenters, the riggers, the joiners, were artists.

To-day what do we find? The art of shipbuilding is, unfortunately, fast fading away, and a shipyard of the present day is a manufacturing plant. There is a foreman for every branch of the work, but he is a master mechanic. He does what he is told. And what tells him? Blueprints of plans which have been developed by men who are not ship carpenters or riggers, or plumbers, or ship fitters, or blacksmiths or machinists, or pattern makers, or joiners, or electricians. Who, then, are these men? Are they the managers, superintendents, naval architects, marine or electrical engineers? No! They are simply draftsmen. These men who have to

* A paper read before the local Association of Marine Draftsmen at Norfolk, Va.

design and develop the problems of ship construction, many who devote their lives to the complex and intricate study of the various trades that their work may be correct, progressive and economical, are merely draftsmen. They must make the structure strong enough, make room for everything, provide a place for everything required in the specifications, order it, make it all fit and furnish it to the yard at the right time so the whole structure may be assembled in accordance with a prearranged schedule. They must understand the fundamental principles of all the trades, must be well versed in the scientific branches of naval architecture and mechanics, understand the methods of operation and navigation to a sufficient degree to develop a machine which will be superior to anything yet built; but they are only draftsmen.

Because of the advances made in machinery for construction purposes which enable tons of material to be worked, where pounds were worked before, ships can be built in a fraction of the time it used to take. But with this enormous output of material comes the necessity for information to correctly put his work through the various shops without waste or loss of time. The joiner bulkheads are sometimes made before the keel is laid. The rigging and its endless fittings are all ready long before the masts are stepped. The whole mass of structure is lying in heaps before the shipways, punched, planed, sections riveted all ready to assemble. Oftentimes we see auxiliary machinery foundations waiting for the various machines a month before they are attached in place.

Has the ship draftsmen made this modern method of shipbuilding possible, or has this modern method made the ship draftsmen possible? Let us see. Ten years ago a battleship of that period of 14,000 tons was built in four years. To-day a modern battleship three times as complicated and twice the displacement is built in 33 months. Merchant vessels are built in a third less time and commercially are a superior product, although their beauty is less and less apparent and unnecessarily so. Why is this development and to whom is the credit due? I will answer that in a large measure it is due to the draftsmen in the shipbuilding profession. I admit that the yard organization and the sub-contract and piecework systems have made it possible to reduce the cost of ship construction, but these systems are made possible by the draftsmen, and in a measure it has entered into the time element, but the progress in ship construction both in design and time is primarily the result of the development and experience of the drafting organization.

The plans the draftsman gives to the yard are the result of deep thought, careful study, and good judgment. If the plan is faulty and the work built to a faulty plan is criticised, he is condemned. But if everything fits, if he has ordered his material with small waste, if his designs are praised by the owners, who gets the credit for it? Very seldom does the draftsmen share the honors; that is all given to those who come in contact with the owners, and they seldom pass it to those whose brains produced the ideas and thereby made them possible.

Take, for example, the cargo-handling facilities of a modern cargo carrier. This problem in itself is a study to which some men outside the drafting profession are devoting a great share of their time. It is one which vitally determines a successful ship from the owner's standpoint. The owner wants to get his cargo in and out of his ship within the smallest possible time. He wants to handle it with the minimum amount of damage, and he don't want to renew his running gear every trip. These facts the draftsman understands and his whole effort is to produce these results. After his structure is developed and ordered and long before the keel is laid his thoughts are centered on this new problem, radically different, yet a part of this great creation. He reads what magazines he can afford to buy, not in the office, for he must draw there, but at home—if he be so fortunate as to have one. He obtains from available sources plans of the ships which have similar cargo arrangements; he spends his vacation sometimes studying other ships and other yards, and his work is constantly on his mind. Few men interested in their work will forget it when they leave the office. They will continue to study and converse on their problems long after they have covered their boards. In this work on this cargo gear the draftsmen will make every effort to have every bolt fit in every hole; will study hour after hour how to keep leads straight to avoid friction and unnecessary blocks and sheaves; how and where to provide a swivel block or a fountain block or fair leaders to avoid chafing a rope. He must go into the calculations of stresses and strains and see that a boom designed to lift 50 tons will do it with safety and that the whole gear will be designed in proportion. He will provide bolsters at the hatches; will locate pad eyes and deck eyes at convenient locations for properly handling the special cargo for which the ship is designed, and he will use his best efforts to prevent any two leads from fouling. Many are the ideas which come before him in his study of the design, and he uses his best judgment as to which he shall develop. And all the while is the necessity to hurry. He knows just when each element in the building of the ship will be ready for his work, and he must not be the cause for delay by not having the plans done in ample time to get the finished product ready for the ship when it is due.

Twenty years ago there were scarcely any ship draftsmen in this country. The White Squadron started a new era in shipbuilding in this country and draftsmen had to be imported. The colleges noted this and began courses in naval architecture. As would be supposed, there were many incompetent men who came to this country at that time, and it was most unusual for the men who began the plans of a ship to stay with the yard until the ship was finished and see the result of their work. As soon as their work reached the yard they left, and many men to-day remember the trouble that often followed when the work was put on the ships. To-day there are many men of fifteen years' experience in the design and construction of ships: men of ability who are progressive, studious, ambitious and energetic; who invite criticism and investigate new ideas. It is because of these men that this article is written. Their importance in shipbuilding is not appreciated, and little thought is given by the shipyard officials for their welfare.

Ship draftsmen are not mechanics. They work with their brains, not with lead pencils and drawing ink. The shipyards do not get the best there is out of them because they do not treat them as professional men, but as tradesmen. Drafting is not a trade; it is a gift, and many gifted draftsmen have left the business because of the lack of opportunity which shipyards offer. At some shipyards in this country a draftsman is apparently considered a machine to make so may lineal feet of lines on tracing cloth a day, a mistake which often increases the cost of a completed ship and makes her less successful as a money earner than if more thought and less lines were required of him.

Some small yards have a library for the use of the draftsmen, but I know of none of the larger yards which has this, yet the large yard is the one that needs most to furnish the draftsmen with information. Every ship built has new problems which are different from any other ships, and it is the draftsman who has to puzzle these problems out. The result is he has to devote his hours of freedom to fortify himself with each new day's demand because, as was before stated, he has to make lines while in the office.

Another thing in which the shipyards are unjust is in the matter of trial trips. The ordinary draftsman cannot afford, on his meagre wage of $4.50 (18/9) or $5 (1/0/10) a day to

take trips on ocean-going ships to study his work. It should be the duty of the yard officials to invite him on the trials so he can see the defects he has made if there are any, or to enjoy the success of his efforts if he has been successful. This will increase his efficiency and make him more valuable to the firm he is employed by and to the shipbuilding world at large. This is another point where the small yards of to-day are more progressive. In the larger yards of to-day a draftsman is indebted the rest of his life almost to his superior officer to be allowed the privilege of accompanying a ship, even if he is given some menial work to prevent his being idle for a whole day.

Let us see what some of the problems are which confront a first-class ship draftsman—problems which he actually has to work out himself and which he is actually responsible for. Let us assume in preparing this list, which incidentally will be incomplete, that the owners have furnished a small sketch of the ship they wish built, generally an impossible design for reasons so numerous it is impossible to state them in this article. Suffice it to state that owners usually want what is structurally impossible to obtain and spaces allotted to machinery and living quarters are so small that much time is required after a contract is obtained to arrange them in a workable design. The contract is usually signed before any preliminary work is begun in the drafting offices; in fact, before the drafting force has even seen the plans. Ten months from date the ship must be delivered to the owners complete, ready for use, etc., under penalty of $200 (41/13/4) per day perhaps, and in rare intervals with a bonus of the same amount for delivery before that date. The ship is built to the rules of some shipping bureau or register, and also to specifications. Material must be ordered at once. Plans must be provided for the yard. There is a scramble of engine draftsmen for the structure in the machinery space, and the whole drafting force is keyed up to a high pitch and nerve-racking tension to satisfy all comers.

The structure is begun. One good man who can think quickly, anticipate wisely, and is accurate, is given the midship section, another the keel, still others the framing, shell, decks, stem, stern, frame and rudder, and the new creature, which in seven months will be afloat on the water, has started. Each man must be capable of handling any problem, every little angle or plate must show the same on every plan if it shows at all, the riveting must all agree, else there is trouble when it goes together in the yard.

Before these plans are well along the plates, and shapes must be ordered without waste yet sufficiently large to be worked, usually a half inch on a plate and two inches on a shape, because the mills will not guarantee to furnish them closer. This will not allow of scaling, for with the plans on one-fourth-inch scale the error would be considerable, hence they must be figured. The pillars and girders are then taken in hand, taking care to support the structure, to keep clear of any possible interference with handling the cargo, to prevent undue vibration in the ship, yet always mindful to save material.

While all this is going on, another man is arranging all this work on a plan, a joiner plan, assembling the work, let us say, and providing a place for all that is required in the specifications, arranging and rearranging the berths and lockers for the crew in a space only half large enough. Still others are calculating the strains and stresses of the hull, to be sure she will stand any stress of weather she may be liable to encounter, to discover if her weights are so located that she will trim right fore and aft and athwartship; to see that she will not turn over either light or loaded, and to see if she will carry the cargo required of her by the specifications. Her cargo-handling gear, her boat stowage, ventilation, scuppers, her multitude of fittings too numerous to mention in an article of this scope, even to the rivets, must all be designed and ordered before the yard can take this work in hand; and if she be built for the passenger trade the interior design with all its complications must be studied and carefully worked out to a successful and artistic finish.

This is barely an outline of what the duties of a ship-draftsman are, yet it is perhaps enough to show the high officials of the large shipyards that they are underestimating the value of these faithful servants in their employ and are not providing proper compensation for what they demand.

Fifteen years ago there were not enough draftsmen of experience in the whole country to plan the work now required by one yard. For that reason the building of ships was slow. By reason of the capabilities of the draftsman of to-day and the fact that he can now fill the yard with material two months after a contract is signed, ships are being built three times as complicated, twice the size in one-third less time, and as the organization of the drafting room is developed the time will be reduced.

It is up to the shipyard officials to assist in this development. The element of co-operation is one of the highest essentials, and if they will offer reasonable inducements the ship draftsman will do his duty, for he loves his work. If he did not, he would long since have left the business, for its returns are at present out of all proportion to its demands.

This article, as you notice, has dealt simply with the draftsman in his work on the merchant hull. The problems which the engine draftsman has to deal with and the draftsman of warship construction are equally difficult perhaps, and the poor government draftsmen have difficulties which would require a separate article to discuss.

However, from a charitable standpoint, let us try to believe that the development in shipbuilding has been too rapid and that the shipyard officials will in time devote some thought to the possibilities of their plants through intelligent consideration of the drafting organization where, by a progressive system of advancement for capable men, they will encourage the draftsman instead of killing his ambition through careless indifference as to his welfare and the idea that he is a necessary evil.

A 45-Foot Motor Cruising Yacht

A full-powered cruiser has just been constructed by John I. Thornycroft & Company, Ltd., for service in the Near East. The vessel was required to possess first-class sea-going qualities, and she has been built 45 feet in length, with 9 feet beam and an extreme draft of 2 feet 9 inches. The propelling equipment consists of a Thornycroft M6 type motor, complete with Thornycroft reverse gear and clutch, using kerosene (paraffin) as fuel, and starting directly on gasoline (petrol). The engine has six cylinders, each 4½ inches in diameter and 6 inches stroke, developing 45 brake-horsepower. The boat has attained a speed of 9.7 knots over the measured course, using kerosene (paraffin) as fuel.

The hull is built of teak on frames of American elm, the keel is also of American elm. The hull to 3 inches above waterline is sheathed with copper. In the fore peak a 100-gallon fuel tank is stored, and a chain locker is arranged above it. The accommodation comprises, forward, a sleeping cabin, ventilated by two cowl ventilators. A ladder and hatch provide access to the upper deck. Aft of this is a very roomy saloon, ventilated by an overhead skylight, and divided from the sleeping cabin by curtains. Following this is the toilet room, and on the port side a well-arranged pantry. Aft of this again is the motor room, containing the engine and reversing gear, two folding cots for crew, cooking stove, fresh-water tanks and tool lockers, etc. The engine case is built with a flat tray top to serve as a table.

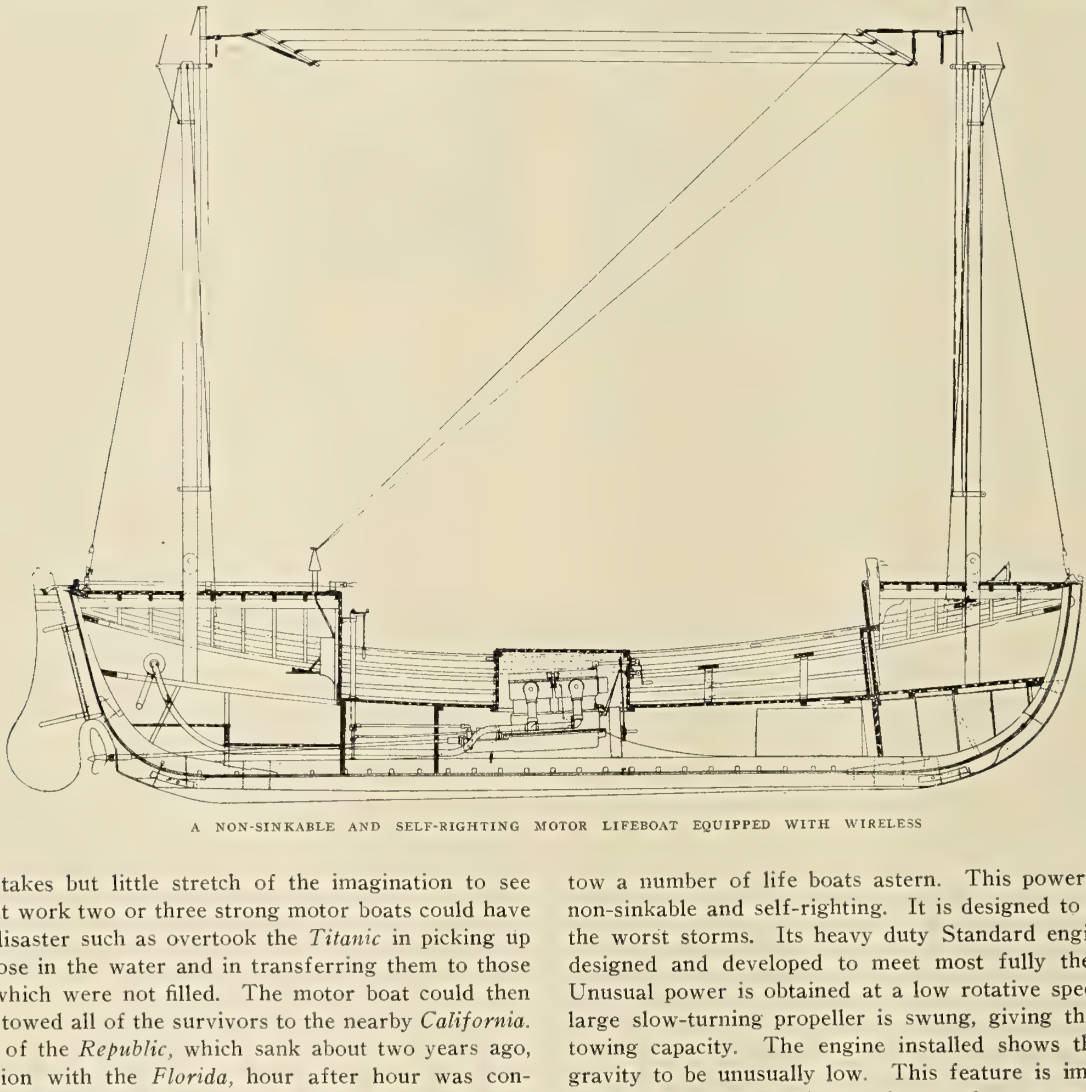
Design for a Motor Life Boat

The strongest count against the shipbuilders and shipowners of the day is that they have neglected the small boat in the wonderful improvements instituted in practically every other direction on shipboard. Not only as regards davits, but the boats themselves have shown little or no modernization. Worst of all, the small power boat has been ignored by steamship owners, in the face of its remarkable development by manufacturers. The power boat both in the United States and in Europe has reached a high state of perfection. American marine engines are bought in large quantities to-day in every part of the world. The navies of the world use power boats very largely. The gas engine for automobile and motor boat uses is one of the engineering triumphs of the present age. Yet few passenger steamers are equipped with even one power boat for use in times of great danger or sudden emergency. It takes but little stretch of the imagination to see what valiant work two or three strong motor boats could have done in a disaster such as overtook the *Titanic* in picking up some of those in the water and in transferring them to those life boats which were not filled. The motor boat could then have easily towed all of the survivors to the nearby *California*. In the case of the *Republic*, which sank about two years ago, after collision with the *Florida*, hour after hour was consumed in transferring passengers of the *Republic* to the rescue ship. Fortunately, calm weather prevailed. How much more quickly the work could have been done had there been at least one power boat to tow the life boats to and fro!

Any modern cruiser or battleship is equipped with a large number of motor boats, and they are invaluable to these vessels. A very potent reason for the mercantile marine to make greater use of the motor boat lies in the fact that under modern conditions it is well-nigh impossible to man the life boats of a huge passenger steamer properly. The seaman of today on the passenger steamer is little better than a longshoreman. He is not trained in the use of oars and has no experience as a boatman; whereas, one man can operate the marine engine. A handful of picked men would be of more use, were motor boats carried, than many inexperienced oarsmen. Furthermore, owing to the introduction of the automobile and the large number of power boats used for pleasure, on any passenger steamer a considerable number of people who are expert in handling a gas engine could be found.

The life-saving service in the United States and that in many foreign countries have very generally adopted the power life boat. The same features which make it far superior to the oar-propelled boat in this service should cause one or more to be carried on all large vessels. In a heavy seaway the ordinary life boat is in constant danger of sinking because of the inability of the oarsmen to keep the boat from being thrown broadside into the trough of the seas.

Such a power life boat as shown in the accompanying plans can be kept by one man head on to the waves and will also tow a number of life boats astern. This power life boat is non-sinkable and self-righting. It is designed to live through the worst storms. Its heavy duty Standard engine has been designed and developed to meet most fully the conditions. Unusual power is obtained at a low rotative speed, so that a large slow-turning propeller is swung, giving the boat great towing capacity. The engine installed shows the center of gravity to be unusually low. This feature is important in a small boat, as all weights are kept as low as possible for the greatest stability. It will be seen that the engine is housed in a water-tight compartment and that all controls are carried outside, so that the engine may be started, stopped and reversed without opening this compartment. Complete control of the boat is had at the tiller, as the controls for the throttle and the reverse gear and clutch are carried aft to where the steersman stands. Water, gasoline (petrol) and other supplies may be carried behind the fore and aft water-tight bulkheads below the floor. The boat's masts when extended are 35 feet high. These telescope and fold down. This operation is performed very simply and easily. Each



A NON-SINKABLE AND SELF-RIGHTING MOTOR LIFEBOAT EQUIPPED WITH WIRELESS

is raised by a single halyard, which in raising the mast also tightens the stays.

Perhaps what will seem most novel in this boat is her wireless equipment. Similar apparatus, however, has been installed in small boats before this. The Austrian Lloyd Steam Navigation Company equipped a life boat with a Standard engine and wireless equipment two years ago, just after the accident to the *Republic* and *Florida*. The boat here shown with an aerial of about 35 feet and spread of about 25 has a sending radius of about 75 miles. Messages could be received from a distance of from 500 to 800 miles.

One can readily see the possibilities in a boat so equipped. One or two such power boats in time of a wreck, besides picking up those in the water and seeing that all life boats were equally loaded, could keep a large fleet together. Each could tow six life boats at a speed of from three to four miles per hour. They could in this way keep the survivors from becoming scattered until such time as some ship could be communicated with and help obtained.

Electric Trucks for Steamship Terminals

BY F. H. HAINES

An electric freight truck which has a maximum capacity of 2,000 pounds and a bulk capacity of six hand truck loads per truck is now in practical operation at several large railroad and steamship terminals at Jersey City, N. J., New York, N. Y., and Savannah, Ga., where it is said to be giving excellent results. It is claimed that the trucks are producing a saving of from 15 to 35 percent in the cost of handling freight, besides facilitating the maintenance of steamship schedules.

Any unskilled laborer can operate the truck at a speed of from 2 to ten miles per hour, for a ten-hour day on one charge of electricity, at a cost of 10 cents (0/5) per day per truck for current. The frame consists of two I sections,

LOADS OF 1,890 POUNDS BEING TRANSPORTED OVER 65 PERCENT GRADES BY ELECTRIC TRUCKS AND OTIS INCLINED ELEVATOR

which extend the entire length of the platform, and is supported by four spiral springs. The wheels are equipped with solid rubber tires, giving the body additional elasticity. The power is derived from a single storage battery, consisting of two sets of 12 cells each, the capacity of which is 120 ampere hours at 60 volts. Power is taken from the batteries through a maximum capacity fuse and circuit breaker and a drum type controller, the latter being mounted in ball bearings between the two frame members, and is connected to a set of resistance, and is operated by a vertical lever moving in a vertical plane within convenient reach of the operator's left hand, through an arc of about 120 degrees, giving five speeds forward and five reverse. However, power cannot be sent into the controller unless the foot pedal, which simultaneously releases the band brake on the jack shaft and throws in the circuit breaker, has been pushed down. The lever to the left is the controller; that to the right the steering lever; and the pedal just above the foot board, or operator's stand, the brake. To increase the bulk carrying capacity, one end is equipped with a hinged iron gate, which may be lowered, allowing 2½ feet additional loading surface.

DIRECT TRANSHIPMENT FROM SHIP TO CARS BY ELECTRIC TRUCKS

Freight is conveyed by the trucks direct from the ship's hatches, through the cargo ports, and over the drop platforms to the pier or into the cars, and vice versa. One electric truck with one operator will carry a load of 2,500 pounds up 20 to 35 percent grades, while it would require eight hand trucks and two to four additional helpers for each truck to carry the same load and negotiate the same grade. The electric truck is also successfully operated in connection with the inclined elevator which is used to convey ordinary hand trucks and their loads over heavy grades brought about by changing tide conditions.

A sling load of 16 bags of grain is hoisted from the hold of a coastwise steamship by the hoisting engine to the discharging deck, where it would have to be distributed to 5 hand trucks carrying 3 bags each, while the entire sling load can be placed on one electric truck direct from the hoister and sent to its destination on the pier or into the cars.

The handling of canned goods and other small package freight from the lower decks to the discharging decks is done by the use of flat boards, containing ring bolts at each end through which rope slings are run and connected to the hoister pennant or fall. This flat board will contain 43 cases of canned goods, weighing 60 pounds each, and is landed directly on the electric truck for discharging to the pier, the flat board being returned to the ship with the empty truck for another load. In discharging the same number of cases by hand trucks, it would require 8 trucks.

The average hand truck speed is about 1½ miles per hour, including loading and discharging, while the electric truck will maintain a speed of 2¼ miles per hour, including loading and discharging, without tiring, as is the case with manual labor; however, the additional time required to load and discharge the electric truck materially reduces the round trip speed, but the saving is brought about by the increased capacity and speed of the electric truck.

There are various kinds of mechanical devices for transferring package freight at railroad terminals having no steamer line connections, and also for transatlantic lines with or without direct rail connections. Many methods have proved practical in this direction, as the freight on railroad terminals is only conveyed to or from the car doors, then dumped, while in the latter case it is hoisted to or from the overall hatches of ships which do not contain side cargo ports, and is placed either on the pier or in the ship. It is, therefore, evident that, in order to mechanically convey freight in this manner through side cargo ports, with which coastwise steamships are equipped, it would be necessary to equip the ship, as well as the pier, with conveying machinery, which is not practical. Therefore the practical utility of the electric truck for service at coastwise steamship terminals, as outlined in the instances just described, is evident.

Shallow Draft Ferry Driven by Gasoline (Petrol) Engines

Except where small boats are used as passenger ferries internal-combustion engines have seldom been utilized for the propelling machinery of this type of craft. A new departure in this direction, however, has been made recently in the construction of the steel car ferry *Henderson,* designed to carry a load of two 50-foot interurban trolley cars, each weighing 87,000 pounds, across the Ohio River at Evansville, Ind., on a draft of about 3 feet. The boat was designed by Morris M. Whitaker, Nyack, N. Y., and built by the Dubuque Boat & Boiler Works, Dubuque, Ia. The distance over which the ferry runs varies from ½ to 1 mile, according to the stage of the river. The schedule of the ferry requires hourly trips each way, the time of crossing varying from six to fifteen minutes, according to the direction of the passage and the stage of the river.

Both the construction of the hull and the arrangement of the propelling and auxiliary machinery are of special interest, because both are unusual. The main particulars of the hull are shown in the general arrangement plans, shown in Figs. 3 and 4, and the complete scantlings are shown in the midship section, Fig. 2. To carry such a heavy load on such a light draft without interfering with the machinery arrangements furnishes a problem which a naval architect seldom meets, and provisions for the strength of the hull in this instance

FIG. 1.—SIDE-WHEEL CAR FERRY HENDERSON DRIVEN BY GASOLINE (PETROL) ENGINES

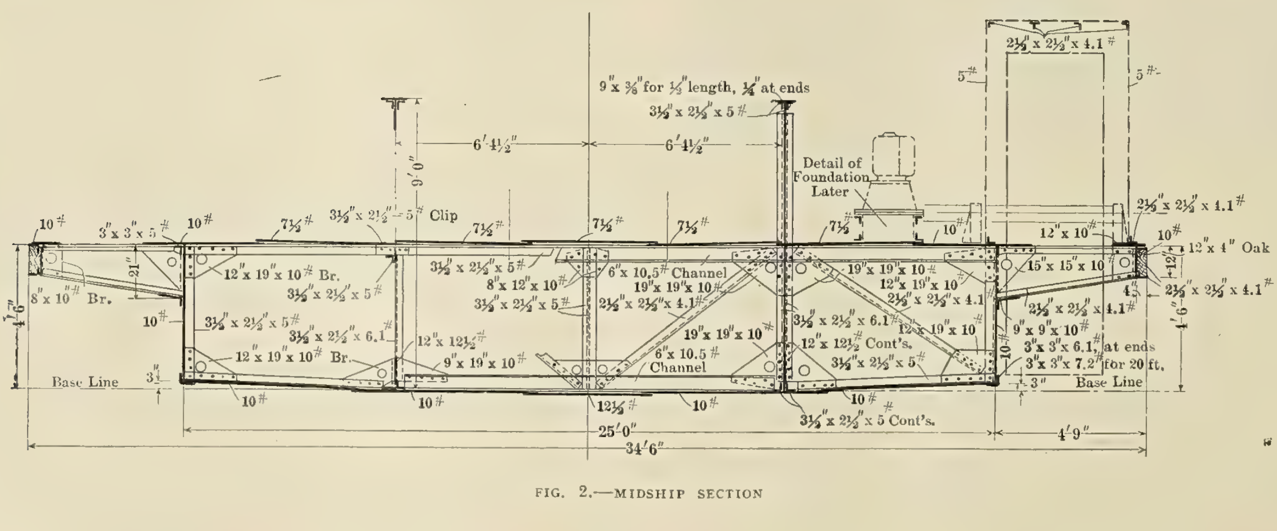


FIG. 2.—MIDSHIP SECTION

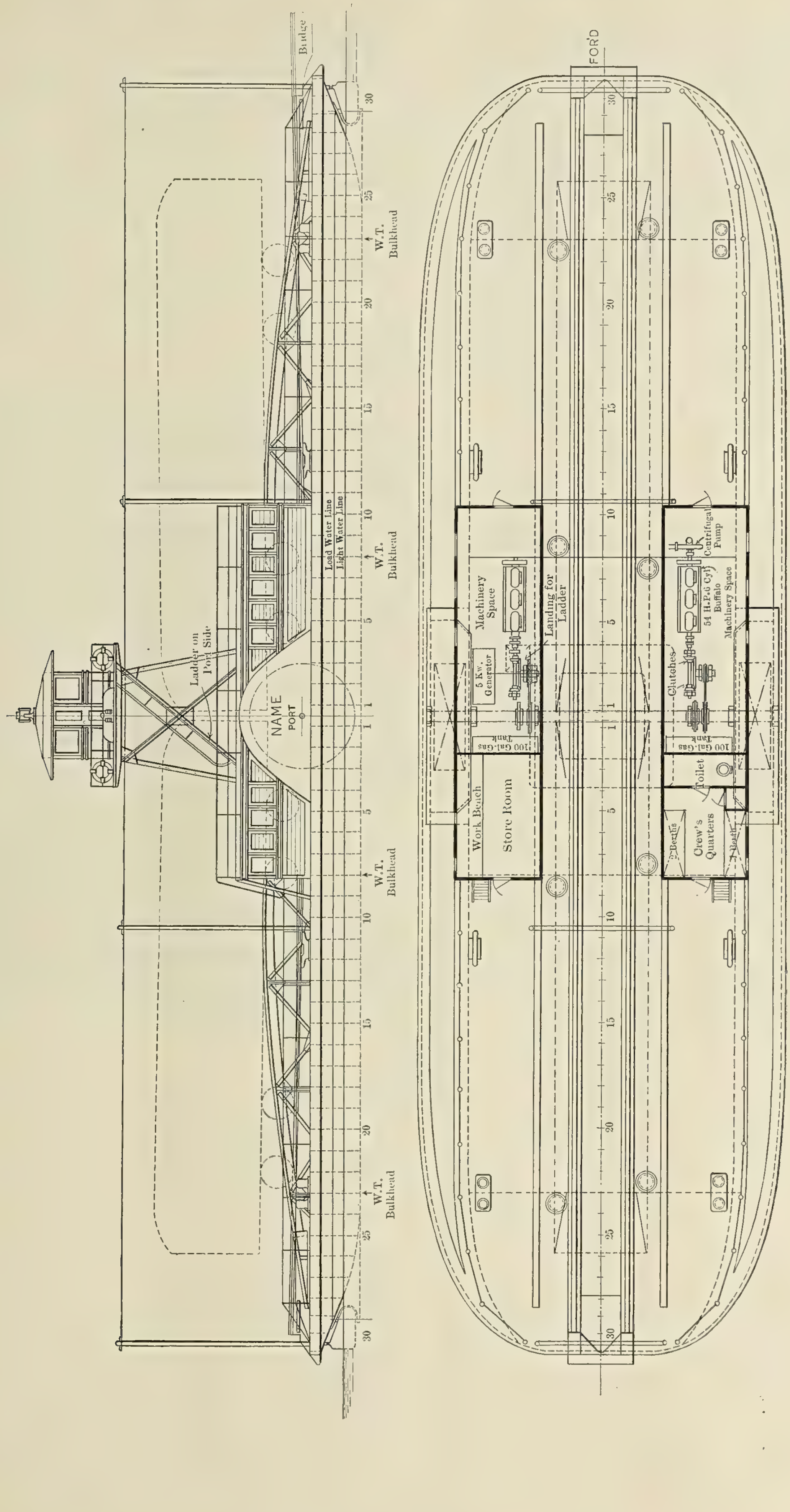


FIG. 3.—GENERAL ARRANGEMENT PLANS OF CAR FERRY

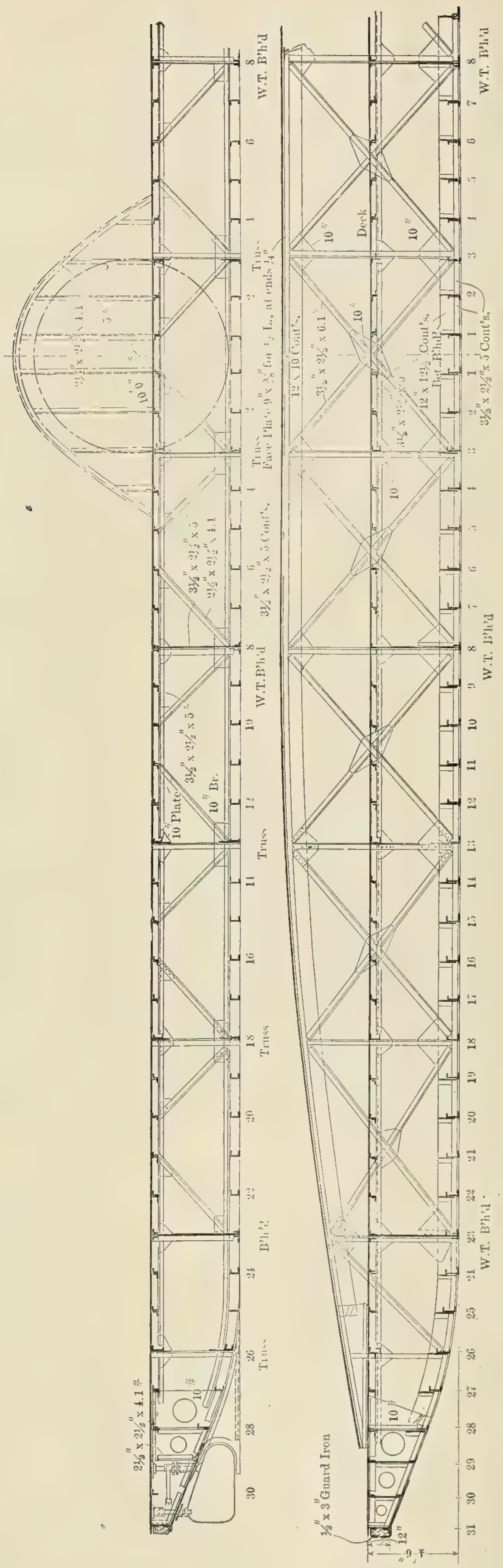


FIG. 4. LONGITUDINAL BRACING OF SHALLOW DRAFT CAR FERRY

are excellently carried out and the machinery arrangement has proved as flexible and reliable as the old-time steam machinery. The boat is 120 feet 8 inches long over all, 120 feet molded length, 25 feet beam molded, 34 feet 6 inches beam over guards and 4 feet 6 inches depth of hold.

Propulsion is by side paddle-wheels. The wheels are independent, although there is a cross-over shaft by which both paddle-wheels can be locked together and driven from one engine. The wheels are 10 feet in diameter with a 3-foot face. Each wheel has ten buckets, 18 inches wide, and the designed speed of the wheels is forty revolutions per minute.

The main engines consist of two six-cylinder, four-cycle, 7-inch by 9-inch Buffalo gasoline (petrol) engines of 54 horsepower each, located in separate engine rooms and operating the wheels independently by means of double clutches and cut steel bevel gears. The motors have double ignition, a Bosch high-tension and Atwater-Kent distributor. The reduction in speed from the motors to the wheels is 10 to 1,

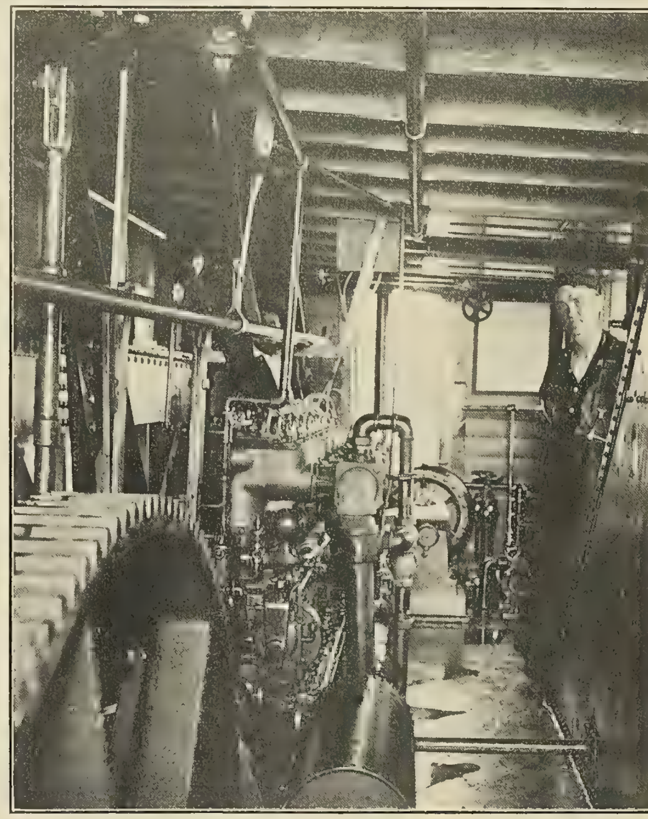


FIG. 5.—ONE OF THE ENGINE ROOMS

and by means of the double clutches (one of which gives motion in one direction, and the other in the opposite direction) perfect control of the wheels is obtained.

There is an independent electric light outfit, supplied by Carlisle & Finch, operating at 550 volts, to supply current for a searchlight and for lighting the trolley cars when on the boat as well as for lighting the boat itself.

Bilge and air pumps are attached to each motor. A large centrifugal fire and bilge pump is worked through a clutch from one of the main motors by means of a silent chain. This pump, which is furnished by the Morris Machine Works, is connected to each watertight compartment on the suction side, and also overboard, so that it can discharge over side or through two hose pipes for fire purposes. It is capable of throwing a 1¼-inch stream under pressure of 150 pounds per square inch at the nozzle.

Lifeboats and other equipment are provided as required by the United States Steamboat Inspection Service.

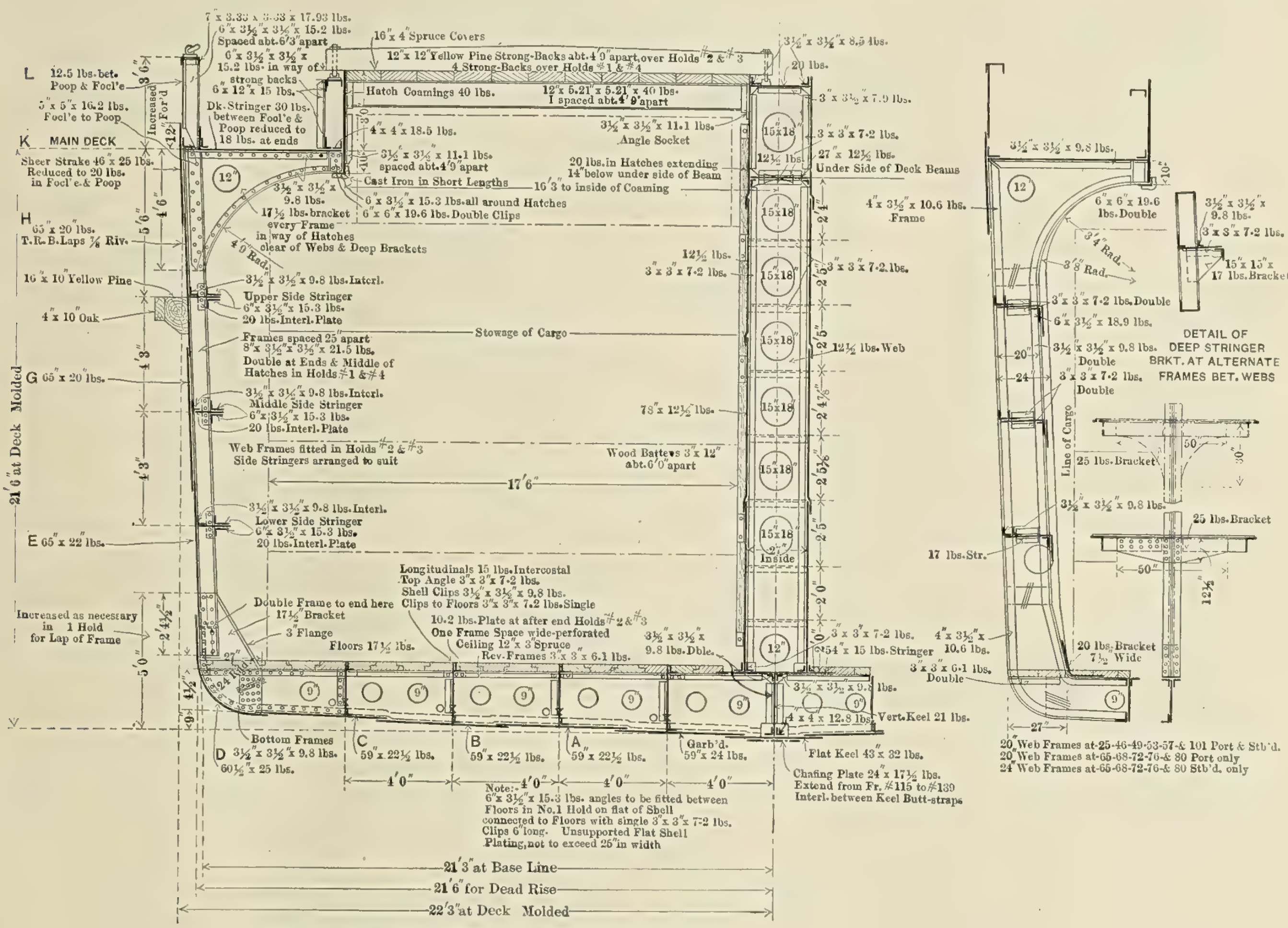
Lumber Steamship for the C. A. Smith Lumber Company

The Newport News Shipbuilding & Dry Dock Company is now building at its works in Newport News, Va., a steam lumber-carrying vessel, the construction of which embodies several novel features. The vessel has been designed by Edward S. Hough, of San Francisco, for the special service of the C. A. Smith Lumber Company on the Pacific Coast, and will be named *Adeline Smith*. Its principal dimensions are as follows:

Length over all	310 feet 6 inches.
Length on waterline	296 feet 8 inches.
Beam, molded, at main deck	44 feet 6 inches.
Depth, molded	21 feet 6 inches.

The principal feature of the design is the adoption of Hough's patent center-trunk construction, which is claimed in lumber-carrying vessels, which are, as a rule, very beamy and comparatively shallow, and have their deck cut away by hatches to such an extent that in the ordinary type of construction structural weakness often develops in the larger vessels, and as they also carry very high deck loads, and nearly all use fuel oil, which is carried in the ordinary type of double bottom, the free surface in the tanks often makes them tender.

Another feature of the design of the vessel is the extent of the cargo hatches, there being four on each side of the center trunk. The hatches are especially arranged to take care of the standard lumber units which have been adopted by the C. A. Smith Company. To suit these units and provide maximum stowage, the main deck is built without either camber or sheer.



SECTION SHOWING CONSTRUCTION IN CARGO SPACE
BULKHEAD No. 18 TO No. 107
LOOKING FOR'D.

FIG. 1

to be especially adapted to lumber-carrying vessels. As shown on the midship section this construction consists of a narrow trunk extending from the top of the floors to the deck, dividing the hold longitudinally. This trunk extends the full length of the cargo hold, and is used for carrying fuel, oil or water ballast, as desired. It is claimed for this construction that the center trunk, acting as a girder, greatly increases the longitudinal strength, and that, being deep and narrow, the free surface of oil is reduced to a minimum, and greater stability thus obtained. These points are especially important

As indicated on the accompanying plans the vessel will have a single deck, a raised forecastle and full poop, with two tiers of deck houses above the latter. The machinery will be located in the stern, and the pilot house and navigating bridge will be aft also, so that the deck will be entirely unobstructed between the forecastle and poop, and thus available for deck cargo. There will be a double bottom of the cellular type under the machinery space for carrying fresh water.

As cargo is generally carried only one way the vessel will usually go north in ballast, and as heavy seas are to be

encountered on that trip it is necessary to carry sufficient water ballast to put the vessel well down at the head. For this purpose the hold is subdivided into four compartments on each side, and compartments No. 2 and No. 3 are arranged to act as deep tanks. In these holds deep web frames are fitted to stiffen the sides, and the hatch covers are provided with special strong backs. For handling this water ballast there will be located in the engine room a De Laval steam turbine-driven centrifugal pump with a capacity of 3,500 gallons per minute.

Accommodations for the officers and crew will be very complete; those for the crew located forward and all other quarters aft. Special accommodations will also be provided for the owners, consisting of private dining room, lounge, three staterooms and two baths. All quarters will be heated by steam and lighted by electricity.

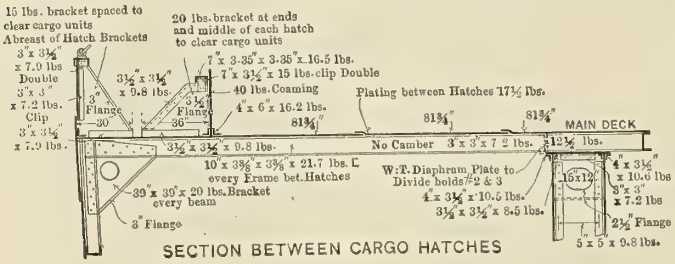


FIG. 2

For deck machinery there will be a steam windlass and two steam capstans on the forecastle deck, and two steam capstans on the poop. Combined steam and hand steering gear will be fitted, with the steering engine located at the forward end of the engine casing. As special gear for handling the lumber is located at the terminals, the only cargo-handling gear on the vessel will consist of two booms on the foremast. One 8-inch by 8-inch double cylinder, double drum steam winch will be fitted on an extension of the forecastle deck for working these booms. An electric plant with two 10-kilowatt, turbine-driven, direct-connected generating sets will be located on a flat in the engine room. There will be two 14-inch searchlights on the flying bridge, and the vessel will have a wireless telegraph outfit. In the engine room there will be a workshop, with power-driven lathe, drill press and emery wheels.

The propelling machinery will consist of a triple-expansion engine, with cylinders 21 inches, 35 inches and 60 inches diameter, respectively, having a common stroke of 42 inches. There are four Babcock & Wilcox boilers. The engine will have piston valves on the high and intermediate cylinders, and a double-ported slide valve on the low-pressure. All valves will be operated by Stephenson link motion. Steam reversing gear of the direct-acting type will be fitted. There will be a separate cylindrical surface condenser with cast iron shell. The circulating pump will be of the centrifugal type, driven by a single cylinder vertical engine. An air pump of the Edwards type and two bilge pumps will be driven from the high-pressure cross-head; all other pumps will be independent. An evaporator of 2,500 gallons capacity per day will be provided.

The four main boilers will have a combined heating surface of 7,200 square feet, and will be arranged with a fore-and-aft room. They will be fitted to burn fuel oil with mechanical atomization, using burners of the Newport News Shipbuilding & Dry Dock Company's own make and type, which have been developed from an extended series of tests in the builders' fuel-oil experimental plant. A vertical donkey boiler will also be fitted.

Launch from the Harbor Dockyard

On March 5, Messrs. Irvine's Ship Building & Dry Docks Company, Ltd., launched from their harbor dockyard the handsomely modeled steel screw steamer *Start Point*, built to the order of Messrs. Furness Withy & Company, Ltd., for their Point Line. The dimensions of the vessel are 390 feet by 50 feet by 27 feet depth, molded, carrying over 7,000 tons on a light draft. She is built to British Corporation classification, having three complete steel decks, with cellular double bottom and fore and after peak tanks for water ballast. The vessel is constructed with deep sectional frames, and is divided into seven watertight compartments by means of six watertight bulkheads. Four large hatches are provided and a cross-bunker hatch amidships, with all the latest facilities for the rapid loading and discharging of cargo, including nine powerful steam winches, exhausting to a Contraflo winch condenser in the engine room, and ten derricks; a powerful, quick-warping steam windlass is fitted forward with steam steering gear amidships and hand gear aft. Electric light is fitted throughout, including large clusters at each cargo hatch. The vessel is fitted with additional bulkheads in the upper 'tween decks to minimize the risk of fire spreading from one end of the ship to the other. The captain, officers and engineers are berthed in large houses on the shelter deck amidships, and the sailors and firemen under the fore part of the shelter deck.

Triple-expansion engines will be supplied and fitted by Messrs. Richardsons Westgarth & Company, Ltd., Hartlepool, having cylinders 26 inches, 42 inches and 70 inches by 48 inches. Steam is supplied by three large single-ended boilers, working at 180 pounds pressure. The auxiliaries include a Contraflo main condenser, a Contraflo surface feed heater and Cascade filter.

A New Fuel Lighter

Where rapid loading and unloading of vessels is essential, as on the Great Lakes, rapid coaling of steam vessels is also necessary, and to accomplish this purpose many types of lighters especially adapted for rapid fueling have been brought out. One of the latest of these, and one which is claimed to be the most rapid vessel of this type, has been placed in use in Cleveland harbor for the Pittsburg Coal Co.

The lighter consists of a steel hull, 156 feet long over all, with a width of 40 feet over all. She is propelled by twin screws, her engines being designed to give her a speed of 12 miles an hour. The carrying capacity of the lighter is 1,000 tons, and it is claimed that she will load 400 tons of coal in the bunkers of a steamer in an hour. The lighter was built by the American Shipbuilding Co.

The arrangements for coaling consist of twenty pockets, located ten on each side of the hull, in which the coal is carried. Each pocket has a capacity of 50 tons, and is provided with two gates, so arranged that the flow of coal to the reclaiming conveyors is accurately controlled. The conveyors operate toward the center of the boat, where they discharge into an elevator, which lifts the coal to a swinging boom provided with a drag conveyor. A swinging and telescoping chute is fastened at the end of the boom, so arranged that it is possible to discharge coal into the bunkers of the largest steamers without trimming. With this arrangement the coaling can be done with a minimum crew, as only four men are required besides the captain.

The conveyor and coal-handling machinery are driven by independent motors controlled from the operator's house placed on top of the elevator.

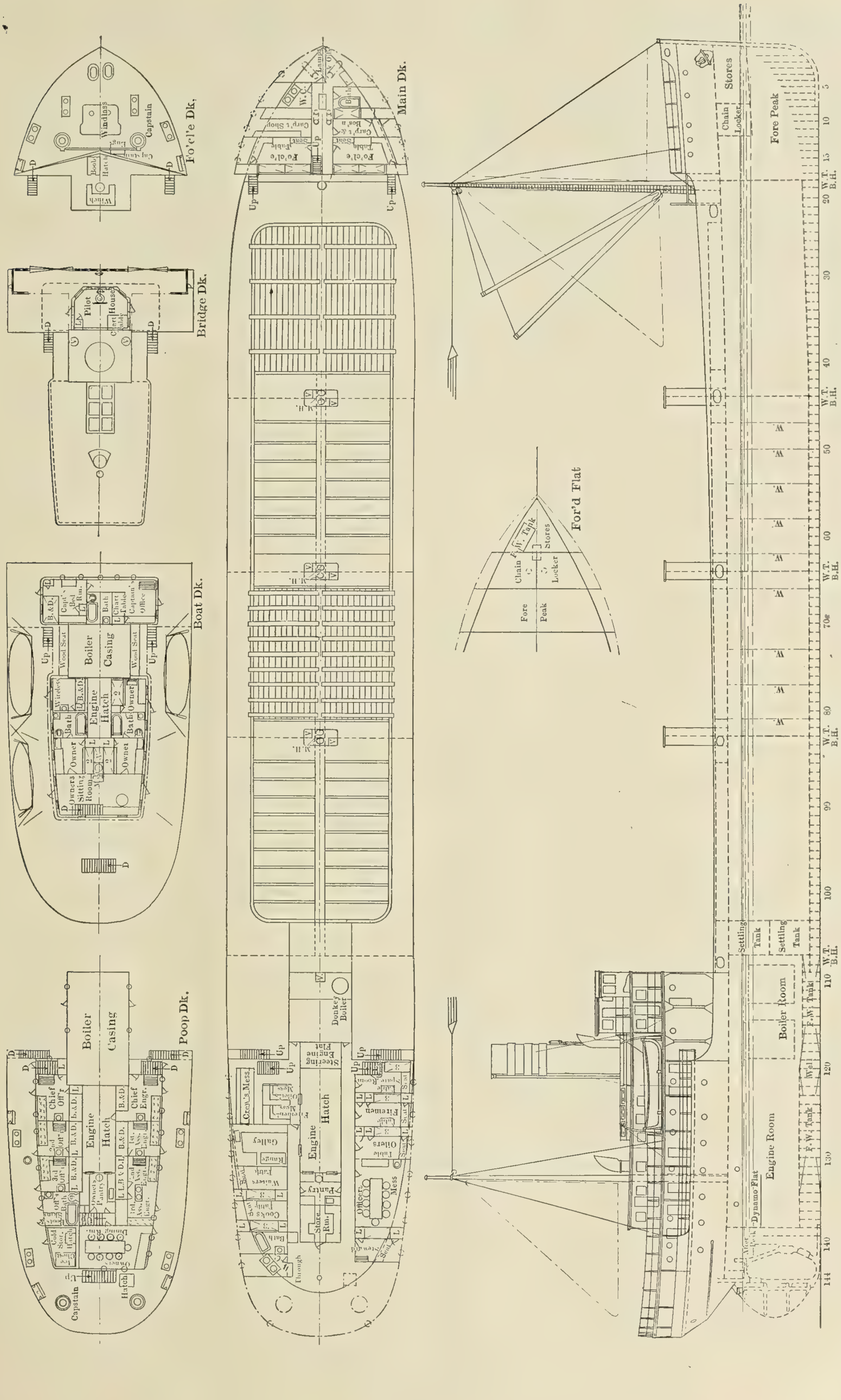


FIG. 3.—GENERAL ARRANGEMENT PLANS OF LUMBER STEAMER BUILT ACCORDING TO HOUGH'S PATENT CENTER-TRUNK CONSTRUCTION

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Overhauling Winches

Deck steam service gives as much trouble at times as all the rest of the ship's gear put together. One of the most annoying experiences out of all the troublous happenings at sea is to be dressed ready for an evening ashore, and just as your foot is on the gangway to have the chief call out: "Mr. ——, your No. 4 winch is stopped; you had better see what is the matter." With a face as long as the Western Ocean, you get below and change, find your tools, and, with a feeling of bitter hatred at heart towards winches in general and that brute in particular, you hunt round for the trouble.

Further annoyance is caused usually when cargo is being whipped, the winches running continuously at full bore. The donkeyman rushes up to tell you that he cannot keep steam up. The usual remedy is to light up a main boiler, which is against all the rules of your company.

One ship I joined when the cargo was being sucked out at top speed. I got so very sick of spending half the day and the best part of the night tinkering at winches that I approached the chief on the matter. Although he was very sore on the subject, I enlisted his aid. The result was that he talked the matter over with the superintendent and got what I asked for. Before sailing for a run to China I looked the winches over carefully and gave the chief a list of what I required for a complete overhaul.

I ordered a complete outfit of piston rings, and, finding that all pins were slack in the valve motion, got a new set of turned pins 1/16 inch larger in diameter than the originals. A couple of reamers for holes of running size to new pins and a set of radius blocks for the links were also indented for. Forged steel keys for the sliding pinions were also obtained. New valve-rod nuts and neck bushes to suit the piston and valve rods were also made ashore.

The pistons, rods, guides and connecting rods, also the valve gear of one side of the winch, were taken down successively to the engine room and thoroughly overhauled. Piston rings were filed to fit the bore of the cylinder in the proper location for the steady pins in the piston. The guide bars were filed straight and new oil channels made. Holes in the valve gear were reamed and new pins fitted. The crankshaft was taken down below, the journals touched up, the eccentric sheaves tightened, straps adjusted and made a good, solid job with no liners. Where the sheaves were out of round, as tested by the straps, they were filed as close as we could get them.

I found it necessary, so badly had brasses been adjusted—some of them had an assortment of six liners each side—to solder thick liners on to the brasses to make a solid job. New studs and bolts were made and fitted where necessary.

The crankshaft having had new keys fitted for sliding pinions and thoroughly overhauled, was replaced and adjusted in the bearings. The next process was to line up the engine both sides.

A piece of flat ⅛-inch steel was made having a slot to take two studs on the cover end of the cylinder and being provided with a string hole in the center. The crankpin was turned up to half-stroke, and a string with a weight on the end from the hole in the string guide, central both at cylinder cover and stuffing box, led through.

The bottom guide bar was then bolted up and linered to suit half the depth of the crossheads. The piston rod and crosshead were then slipped into place, and the top bar adjusted to suit the travel of the crosshead. The bottom bar should be tested with a straightedge for spring, and a single liner only should be used under each end of both bars. The piston is now put on after the new neck bush is put in place and the gland hung on. The cover joint is made, thus boxing up the cylinder.

The piston was then bumped either end of stroke and a line scribed on the top bar to show the extremity of travel. After the crank-pin brasses have been carefully adjusted to the pin, couple up the rod and test the clearance at each end of the cylinder by turning the crank and noting the distance the crosshead is at each end of the stroke from the marks made on the top bar. By halving the difference found, the thickness of the necessary liner at the foot of the connecting-rod is obtained. Do not give the cylinder unnecessary clearance by using a thick cover joint. Brown paper and boiled oil is a quite good joint. The foregoing was completed both sides of the winch.

The valve gear gave more trouble. The forged blocks put aboard for the quadrant links proved to be ¼ inch too large in every dimension, and, as we had twelve winches, this meant twenty-four blocks to be chipped and filed all over, or 144 faces in all. The metal proved tough, and I gave them up reluctantly as a bad job. The existing quadrant blocks were ⅛ inch slack to link after the latter had been filed parallel in the radius. To meet the case I made Guntz metal shoes of ⅛-inch metal, turning over the ends square to fit the blocks.

These shoes I tinned with a soldering iron on the inside all over. Next, taking a piece of ¾-inch steel plate, I made this a good, red heat and stood two blocks upon it, with soldering fluid, solder and iron and a large supply of patience, especially the latter. I succeeded in tinning the face of the block, placing a good dose of solder on the tinned face and laying the shoes for a moment or so face down on the hot plate. I slipped the shoes over the block and quickly placed the block in a vice and kept the shoe nipped on it until cold. A few rubs with a file and I had a beautiful fit in the radius link. No pins to secure the shoe were used, as the fork of the valve rod would prevent the shoe working out, even if it became loose.

As a matter of fact, when in Antwerp, four years later, I found the same steamer discharging there. Going aboard, I found my shoes were still in place and tight as a bottle.

The swinging links of the reversing gear were reamed out at the pins with the rest. The adjustment of travel of the radius link was done by drilling holes in the reversing lever quadrant and driving taper pins home at the extremity of travel, so that the blocks could not bottom in the radius links. In fact, I allowed ½ inch clearance at either end to increase the economy of working.

Valve faces were broken up with a file and trued as far as possible. The cylinder face of the valve being difficult to get at, we contented ourselves with breaking this up with a block file. The horns of the valves close to the nuts were dressed off flat, and the valve motion was adjusted to set the valve by single liners under the foot of the eccentric rod.

As Tuck's or round canvas packing, usually employed to

pack winches, is unsatisfactory, the packing (wire-woven asbestos) for the high-pressure main engine valve rod was split lengthwise into suitable sized square pieces and used to pack all the glands.

The twelve winches took all four of us working all our time off watch for five weeks, and some part of our watches as well. But during the remainder of the time I was in the steamer (two years) the winches were never touched, except to pack. During this period the winches were running 150 consecutive days continuously, frequently 12 and 14 hours at a stretch. We did a spell of coasting trade and never had a winch breakdown.

Many chiefs have a belief that winches were put on board to give healthy exercise to their juniors, and think that unless the juniors are overhauling winches piecemeal more or less on every run they are neglecting their duty. But it is my firm opinion that one complete overhaul once in eighteen months or two years is ample, if thoroughly well done. Also, there is a tendency to follow the practice of the main engines and use a number of liners for winch brasses. Experience has shown me the fallacy of this. Winch brasses should be metal to metal, no liners whatever being used except a single thick liner at each end of the guide bars and liners under the foot of the eccentric and connecting-rods. The clearance at the ends of the stroke on pistons are frequently neglected, both on main engines and winches.

Increased economy in fuel is quite marked by careful adjustment of auxiliary gear, and badly adjusted winches run away with more coal than they are ever given credit for.

As an instance, I was consulted in reference to a small steam plant ashore, which did not develop the required amount of power and seemed high in its consumption of coal per horsepower. Upon putting the plant under the proper test conditions, I found that the boiler feed pump was using 15 percent of the total amount of steam produced.

Deck service steam joints have a happy knack of giving out at inconvenient times. Frequently long ranges of pipes are fitted without provision for expansion. One range of copper pipe I sailed with had no such provision. In 50 feet the expansion endwise was 10 inches as measured. Under these conditions nothing but trouble with joints or deformation of the pipe could be expected. As a remedy, bowling hoops, large vertical round turns of pipe 3 feet in diameter, were fitted on each range of pipe, either against rails or deckhouse, and no further trouble was experienced, the elasticity of the hoop taking care of the expansion.

In conclusion, were I a superintendent of a line of, say, fifteen steamers, doing a regular trade, it would, I think, pay the company well if I secured a really competent man and paid him well to look after the deck gear. I would put him on board with a lathe, boring apparatus for cylinders, valve seating gear and quite a big kit. He would sail in that ship until he had everything quite O. K., drop off at a convenient port and transfer to the next steamer along, keeping all his tackle going until he had made a complete round of the vessels of the company. The junior engineers would give him help, and he would, subject to certain written orders, be under the orders of the chief.

Such a course would save many a heavy port bill for the owners; the work would be efficiently done, the chief being held responsible for the proper employment of the suggested man's time. As a rule, the type of man who does what is despairingly called dock-walloping does as little as he can, and that as badly as possible. By the employment of the course I suggest there would be no incentive to do the work other than well. As the tackle would be continuously employed, it would cost less than putting in expensive gear as a permanent addition to the ship's outfit.

A. L. Haas.

London.

How to Deal with a Loose Crank Pin

The usual method of construction where cranks are not forged solid, but built up (and the latter method is almost essential for vessels of large size), is to turn the pin a shade too large for the hole bored in the web when the parts are cold. The webs are then brought up to a good red heat and, while they, and the pin holes in them, are thus expanded, the pin is placed in the holes. When this has been done cold water is poured over the whole work, causing the web to contract onto the pin and grip it firmly.

This method of contracting the webs onto the pin, while a very satisfactory one, if the job has been well done and if the pin has been proportioned exactly so as to have a good shrinking fit, sometimes leads to trouble at sea, inasmuch as the coefficient of expansion of mild steel is small and it is difficult to exactly gage the right diameter of the pin relatively to the holes. Should the pin work slack great trouble is given to the engineers, and if it is allowed to remain slack for any length of time it can easily lead to a total breakdown of the engine.

When a slack pin is found the engine must be stopped at once, if the vessel is not on a lee shore or in the midst of traffic, and in any case very great care must be taken, as the working of the pin in the web would soon make it a bad breakdown. The crank should be placed upon its top center and four or more holes should be marked off, in such a position that the holes, when drilled, will be half in the pin and half in the web. It will be found that 1-inch tapping holes will be about right. These holes should be carried into the metal about the thickness of the web, and should be tapped. Some screwed plugs should then be made a good tight fit in the holes, and it will be found that this will make a sufficiently strong and sound job to bring the ship home under full steam.

T. T. F.

Auxiliary Electric Plant Driven by an Oil Motor

The recent appalling disaster to steamship *Titanic* must impress everyone with the great difficulties under which those in charge of a ship work when passengers have to be transferred to the boats, and it is obvious that this difficulty is enormously increased if this transfer has to be made in darkness. In the case of the steamship *Titanic* the special construction of the ship with boilers in small groups in separate compartments appears to have enabled the engines driving the dynamos to have continued at work long after the collision. In most ships such a collision would have almost immediately allowed water to rush into the boiler rooms and put out the fires, thus shutting down the engines and throwing the ship into darkness, which, undoubtedly would have increased the loss of life. The White Star Company evidently realized this possibility when designing the steamship *Titanic*, but a further development by the same company in the same direction will perhaps interest the readers of this journal.

The installation referred to was installed a little while ago on the new White Star liner *Megantic*, by Mirrlees, Bickerton & Day, Ltd., on behalf of the White Star Company and Messrs. Harland & Wolff, having for its object the continuance of the Marconi apparatus, and of a considerable portion of the lights, even after the whole of the steam machinery below has been stopped by an accident such as that mentioned above. In this scheme a 45-brake-horsepower Mirrlees-Diesel oil engine, directly connected to a dynamo, is installed on an upper deck, and from the dynamo a separate circuit is taken round the ship and connected with lights fixed in the main passages, companionways, saloons, etc. This circuit is also arranged to provide lights in the neighborhood of the boats, in addition to being connected with the Marconi apparatus.

From the above description it will be seen that in case of a serious disaster such as that on the steamship *Titanic*, a supply of electricity would be continued on board the ship and give light for the free movement of people about the ship, also for the launching of the boats, as well as giving current for the wireless telegraphy right up to the last moment when the upperdeck sinks below the sea.

The installation on the *Megantic* is set to work daily as darkness approaches and continues until daylight, quite irrespective of the fact that the steam-driven electrical dynamos are working. This is done so as to avoid any rush or hurry to start up the plant in case of anything happening in the night. Of course, an independent plant of this kind could be driven by other forms of engines than the Diesel, but with steam or gas engines the space occupied would be greater and the handling of coal on an upper deck would cause considerable nuisance. Gasoline (petrol) or kerosene (paraffin) engines might be suitable for the work, but the oils they use would be quite unsafe on board a large ship, and in fact are prohibited by Board of Trade regulations. The oil used on the engine just mentioned is cheap residual petroleum; *i. e.*, the heavy residue left from crude petroleum after all the light oils have been distilled off.

It is believed that the arrangement described is a life-saving appliance of the greatest value, as with ample light boats can be much more quickly and safely launched than in darkness or semi-darkness. Also, the extended time during which the wireless telegraphy apparatus can be worked gives a greater chance of help being obtained. The fact that the White Star Line has been the first to try this scheme proves their desire to do everything possible to secure the safety of their passengers. Chas. Day, Managing Director,
Mirrlees, Bickerton & Day, Ltd.

Hazel Grove, near Stockport.

Two Breakdowns

An air pump plays such an important part in the economy of the marine steam engine that a breakdown not only causes stoppage, but if the damage is beyond the limited resources of the engine room such a breakdown leaves a steamer in an awkward plight. All the pumps in an ordinary 10-knot freighter are driven by levers from one engine (high-pressure, intermediate-pressure or low-pressure); practically no important part is carried in duplicate, as the breakdowns usually are confined to replacement of valves.

A steamer left Marseilles for the Black Sea, returning 16 hours later for repairs, with steam coming through the engine-room skylight in volumes as she proceeded to a berth. The cause was curiously simple. The air pump was overhauled in port, the valves (of fiber) in the bucket were replaced by new. The distance between seat and guard of the valves was ½ inch, the valves 5/16 inch in thickness. These valves were of such poor material that after a short spell of duty they swelled up tight to the guards, when the descent of the bucket on an unyielding mass of water played the mischief all round. The air pump rod was bent, a pump crosshead bent, both caps of the bearings were torn off at the fulcrum of the levers, breaking away part of the framing on the columns. The levers themselves were also badly twisted. Thus at one stroke the whole of the pumps were rendered useless.

After a short consultation, the chief decided to put back to Marseilles for repairs. To do this the low-pressure engine, by which the pumps were driven, had the slide chest cover removed, and after clearing up the wreck a bit the steamer arrived back in port exhausting steam into the engine room. The donkey pump was used to feed the boilers, sea-water, of course, being used. Repairs occupied four days, the defective fiber valves which caused the trouble being replaced by metal disks of the Kinghorn type.

The second case was even worse, as the steamer on which it occurred had about 1,000 miles to run to her destination, the only explanation possible being that the feed pumps were defective, failing to deliver to the boilers for an appreciable time before the smash came. A quantity of water, therefore, accumulated in the condenser, and the motion of the ship thus projected more water into the air pump than could be dealt with by the overflow. The barrel of the pump burst, the cover was wrenched up, the rod bent double and the bucket torn off, twisted and broken in several pieces. Repair was out of the question. Fortunately, the damage was confined to the one pump, the remaining pumps being good and serviceable. A long run was completed with no air pump and without a vacuum on the condenser.

To prevent the possibility of internal pressure, a hand-hole was removed from the top of condenser; connection was made to the bottom by means of two pieces of flanged steam pipe taken from the deck. The bottom of the feed pumps having covers, made this easy at one end, but the bottom of condenser was drilled and studded to form joints there.

A slower run was made by the steamer, but the results were creditable; and—although I do not remember all of the details—the condensed water was fed back to the boilers, and the diminution of speed not so great as might be expected.

It was fortunate that the steamer was of a modern type, in which the pumps were lower than the condenser, as feed pumps of the ram type on the main engines are unsuitable for a suction lift, the pump chamber filling by gravity. This is arranged for when the pumps are fed in the ordinary way, the hot-well being level with the suction valves of the feed pumps.

Failing the method used, it would be possible in most ships to circulate the condenser with the bilge donkey pump, feeding the boilers with the feed donkey pump, using connections provided for the purpose. But these pumps are provided for duties of an intermittent character, cases having come under my notice where the feed donkey failed to deliver into the boilers while under full steam. In any case, a good deal of trouble would have been experienced using the donkey pumps in this fashion. Modern boats of a better class now carry their pumps as auxiliaries, being separate from the main, as quite 60 percent of minor breakdowns on the older type engines were due to pump troubles.

In a steamer having the pumps lower than the condenser the foot valve usually fitted to the air pump can be dispensed with, even if the pump is not of the Edwards type. In the first case the breakdown could not have occurred if the foot valve had been absent, the mass of imprisoned water between bucket and foot valve being responsible for the damage done. The valves were of a bad type. Fiber has always a tendency to peel, and I consider the makers of the defective valves morally liable for the damage done.

In the second instance the overflow from the hot-well back to the condenser must have been small or choked; the cause quoted seems to be the only possible to meet the particulars brought under my notice at the time. As cessation of the clack of the check valves should have been noticed as soon as it ceased, some amount of blame would seem to rest on the charge of neglect. Observer.

The *Hardware Trade Journal*, the *Cabinet Maker and Complete House Furnisher*, the *Goldsmith's Review*, the *Export World, El Comerciante Argentino* and other publications issued at 31 Christopher street, Finsbury Square, London, E. C., by several companies, have all been amalgamated with Benn Bros., Ltd. Mr. E. J. P. Benn, managaing director of the new company, is director and publisher of International Marine Engineering at the same address.

Review of Important Marine Articles in the Engineering Press

On the Measurement and Automatic Recording of Dead Reckoning.—By F. R. S. Bircham. The paper proper considers the work already accomplished in this line by others, describing briefly their inventions and the service they render. The author then presents a summary of the requirements for a machine such as is needed for the accurate automatic recording of a ship's course, making allowance for turns, error in distance while ship is altering speed and error in course when following. The requirements which he considers necessary for the device are: 1. The placing of small craft on the same level with larger ships in regard to dead-reckoning position, and enable that position to be read off instantly at any moment. 2. Ability to be operated by a person not skilled in navigation. 3. Ability to work out a position more accurately than at present possible when speed and course have been altered frequently. 4. The recording of alterations of course on strip of paper and number of miles steamed and time. 5. Indicators to be resettable so that recorder may be corrected from time to time. In a lengthy appendix following the author then describes in detail a device invented by Lieutenant F. G. S. Peile, R. N., which fulfills the above-named qualifications. The mechanism being somewhat difficult to describe concisely that will not be attempted here. All of its operations are automatic, the adjustments and allowances being set by the navigating officer and requiring but a moment's attention, thus giving an accurate record even in times when the officers have little attention to give to the matter of dead reckoning. Illustrated with drawings.—Read before the Institution of Naval Architects.

The Shipbuilding Industry of Germany.—By Count Ernst von Reventlow. A general review of the growth of German shipbuilding, with reference to the legislation used for the assistance of private industry. Perhaps it is not so well known in the United States as abroad that German shipbuilding is of recent origin as applied to vessels of considerable size. For some time the leading German shipping companies bought their ships in England. There, orders of any size could be handled in the shortest time, and only the requirements of the German mail subsidies brought these orders to the home yards. It was through the foresight of Prince Bismarck, who introduced the bill into the Reichstag, that contracts were made with steamships built in German yards, and so far as possible of German material, for carrying the mails. This act, togther with the naval shipbuilding brought to the yards on account of the upbuilding of the Imperial navy in the years following, has given the yards enough work to enable them to be brought to a high state of development. Especially after the *Dreadnought* type began to influence naval shipbuilding the leading yards enlarged their plants to accommodate the new order of work, and the policy of the German navy to build equal to the best has recently brought out several ships that are considered highly by naval constructors of all the Powers. The latter part of the paper is devoted to descriptions of the private shipbuilding yards in Germany, among which are the Vulcan Company of Stettin, the shipyard of F. Schichau of Elbing and Dantzig, Blohm & Voss, the Howaldt Works, the Weser Company, the Krupp Germania Yard at Kiel, the Bremer Vulcan and others. 9,500 words, illustrated.—*Cassier's Magazine,* April.

The Battleships of the New Kaiser Class.—A comparison of points of design, principally of armament, of the latest class of German battleships, as instanced in the *Prinzregent Luitpold,* recently launched, with the latest types in other navies. The principal dimensions and specifications of this class of ships are: Length, 564 feet 3 inches; breadth, 95.15 feet; draft, 27.2 feet; displacement, 24,500 tons. A speed of 22 knots is expected, and although the motive power given is 25,000 horsepower, the actual will probably be much more than this. As shown in a table accompanying, the size of this class exceeds that of the *Conte di Cavour, Jean Bart, Settsu, Hercules, Viribus Unitis* and *Petrapawlovsk,* but is exceeded by the *Arkansas* and the *Moreno.* The speed expected exceeds all those named except the *Petrapawlovsk* and *Moreno.* The main battery of the *Kaiser* class consists of ten 12-inch guns mounted in five turrets, so that six guns will fire ahead, eight astern, and all ten broadside. Indications are that the 14-inch gun will soon become the standard big caliber gun in the German navy. The armor belt is carried out to the ends of the ship. Time of building for the ships of the class averages about 37 months from laying the keel. 1,400 words.—*The Engineer,* March 29.

The Twin-Screw Motor Ship Selandia.—Paper Third. This installment of the series tells of the engine-room experience of a traveler on the *Selandia* and his opinion of how the Diesel motors behaved in actual practice. It was found that the engineers soon came to feel familiar with the new type and the voyage was uneventful throughout. The motors were a trifle more noisy than a well adjusted steam engine, but this may be improved with further experience. The vibration was noticeable in the immediate vicinity of the machinery space, but at least part of this was due to fast-running auxiliaries. The reversing was accomplished easily and quickly. To the average marine steam engineer the number of rods about the motors might seem excessive, but for the work to be done by them the number is a minimum. The engine-room staff was finished with its work a few minutes after tying up at the end of the voyage, there being no ashes to dump, fire to draw, or cleaning up to be done. The fuel consumption was given as 11½ tons of Roumanian residual oil per 24 hours for the full 2,500 brake-horsepower. This was slightly better than the guarantee. Illustrated with plate drawing of plan and elevation of engine. 3,500 words.—*The Engineer,* March 22.

A New Marine Diesel Engine.—An illustrated description of the new marine Diesel engine being built by Messrs. Franco Tosi, of Legnano. It is of 500 horsepower, two-cycle type with four cylinders and attached double-acting scavenging pump, run from rocker arm, and separate oil fuel pumps for each cylinder. Special features are the separate piston rod and connecting rod, arrangement for examination of piston, water cooling and arrangement to start part of the cylinders on oil whereby engine may be run smoothly at dead-slow speed. A detailed description is given of the reversing mechanism. The large experience of this firm in other types of Diesel engines augurs well for success in the mechanical end of this design at least, and the general excellence of the design predicts for it a successful commercial career. 4,900 words.—*The Engineer,* April 19.

Parsons' Steam Turbines for an 18-knot Ocean Liner.—A complete detailed description of the machinery of this ship, whose name is omitted but may be readily guessed. The installation is compound, consisting of one high-pressure turbine, having four expansions of sixteen rows of blades each and two low-pressure turbines in parallel, each having eight expansions of eight rows of blades. On the same drum with

the low-pressure turbines are the reverse turbines, each having four groups of nine rows of blades. The blading of all the turbines is so arranged that the thrust may be taken up as nearly as practicable by the steam pressure. Thrust blocks are provided for the difference in pressure of thrust, due to variation of speed from the designed speed. Numerous detail and assembly drawings illustrate the installation very clearly. On trial the plant has developed about 20,000 shaft-horsepower and drives the ship 18½ knots. The designed speed of the shafts was 290 revolutions per minute.—*Engineering,* March 22.

Marine Motor.—The description of a very satisfactory design of motor built by Messrs. Simpson, Strickland & Co., of Dartmouth as an auxiliary for the barge yacht, *Thoma II.* Besides being a description of this installation, the article is a commentary on the principles of gas-engine design in general and emphasizes the important features to be considered, especially that of accessibility, of all parts that need any attention whatever, the author claiming that this is desirable even more than any equivalent saving in weight, space, or cost. After showing how every part of this engine is thoroughly accessible, the author takes up in considerable detail the description of the lubricating system, arrangement for keeping moisture from the carburettor, and gearing of engine to the propeller shaft. The arrangement shows the motor placed up on deck and connected to the shaft by means of gears and a chain. The cylinders are not only placed slightly off the center of the crankshaft, but the entire engine is placed considerably off the center of the boat. The engine has four cylinders, 4¾ inches by 5½ inches, which give 32 horsepower at 800 revolutions per minute. Illustrated by drawings and photographs. 4,900 words.—*The Engineer,* May 3.

A Commercial Type Marine Motor.—This article deals with the mechanism of a four-cylinder oil engine designed for the heavy service of fishing smacks, barges, and such craft. The motor's cylinders are 8¾ inches diameter and 10¾-inch stroke, and at 350 revolutions per minute develops 38 brake horsepower on a consumption of 0.63 pint of Rocklight oil per horsepower hour. The general design is very good and shows much care and forethought in providing in convenient places on the engine location of the numerous auxiliary parts. In operation it is said to be quite satisfactory. Blow lamps are used to heat the vaporizer when starting. Two ignitions, Bosch high tension magneto and coil and accumulator, are fitted. Reversing mechanism is quite heavy and suitable for the rough handling to which it is liable. Accessibility has been well emphasized in the design. Well illustrated with photographs and drawings. 5,200 words.—*The Engineer,* May 10.

Engine and Boilers for a Dutch Colonial Government Steamer.—A complete equipment of propelling machinery has recently been supplied by Messrs. McKie and Baxter, of Glasgow, for the Dutch Colonial Government. The plant consists of two large Yarrow boilers so designed that coal or oil may be fired with very little change of fitting, and a four-cylinder triple-expansion engine driving a single screw. The engine has cylinders 16, 26, 30, 30 inches diameter and 24-inch stroke, balanced on the Yarrow-Schlick-Tweedy system, and expected to develop 1,500 indicated horsepower at 200 revolutions per minute. The condenser, which is constructed on the Contraflo system, has a cast brass body. The main steam pipe is of solid drawn steel. The fuel-oil apparatus is on the Wallsend Slipway Company's system and works in conjunction with the forced draft system and heated air supply. Illustrated by photographs and several sheets of drawings. 500 words.—*Engineering,* May 10.

Electric Power in Railway and Marine Terminals.—By R. H. Rogers. This article tells in a general way of the greatly developing need of adequate terminals in handling railway and steamship traffic, and shows the direction in which this need is being met in New York by the Bush Terminals and in Seattle by the newly planned Harbor Island Terminal. The opening of the Panama Canal will see such a great and sudden increase in traffic that few ports will be able to take care of the increased business which will come to them. The obvious solution, it is claimed, is the use of electricity along the lines already begun at these two examples of terminal stations. Illustrated. 3,100 words.—*The General Electric Review.*

New Electric Welding Process.—Messrs. Siemund & Wenzel, electric welders, of Liverpool, have introduced a new method of electric welding which has been very successfully used. The method is as follows: The current is obtained from a generator running from 30 to 60 volts, direct current. This generator has an adjustable rheostat in series with the field, which, together with the field, is in shunt to the armature. The positive pole of the dynamo is connected to a quieting resistance coil, and from this coil to a welding clamp which holds the welding wire. The welding clamp consists of the main body and a spring metal blade, both of soft iron. The clamp is wound with a number of turns of insulated copper wire, which, being connected to both ends of the clamp, constitutes a branch circuit through which passes a portion of the welding circuit corresponding to the drop in tension between the points of the clamp, and magnetizes the clamp and also the welding wire, which is held by it to such a degree that as the molten metal at the end of the welding wire detaches itself, it will follow the lines of force and deposit itself at the point to be welded. Extensive repairs on such work as boilers, furnaces, plating, stern frames, have been successfully made. 1,400 words.—*The Steamship,* May.

Some Aspects of Diesel Engine Design.—By D. M. Shannon. Paper read before the Institute of Engineers and Shipbuilders in Scotland, April 23. The paper is full of figures and facts of practical importance for the Diesel engine designer. Commencing with a general consideration of the subject of efficiency of the Diesel engine as compared with the reciprocating steam engines and turbines, the author states that the oil reciprocating engine is only a step on the way towards the oil or gas turbine, whose difficulties none but the experimenters fully realize. The question of limits of size of the Diesel engine of the present form, he thinks, presents no insurmountable difficulty, and a design is suggested that would make possible as large a marine plant as any yet built or building with steam as the motive power. From this hopeful beginning, Mr. Shannon goes into the question of crank-shaft sizes, best number of cylinders and arrangements of cranks for twisting and bending moments, his statements in figures fortified by formidable tables and diagrams of loads and moments. Other points considered are main bearings, connecting rod caps and bolts, valve gear diagrams, and air compressors, this last in great detail. As a whole, the paper is one well worth study by all interested in oil-engine development. 5,900 words.—*Engineering,* May 3.

Radiotelegraphy with Special Regard to Ship Installation.—By Director Bredow, of Berlin. Abstracts of a paper before the thirteenth meeting of the Schiffbautechnische Gesellschaft. An account is given of the rapid commercial development of German radiotelegraphy to a leading position, and the scientific investigation which has resulted in present-day knowledge of what may be done and how best to do it, in this line of experiment. Taken up at some length are the subjects of range, wave length, influence of earth and atmosphere, power required, instruments, and the geographical distribution of stations. Illustrated. 3,900 words.—*Engineering,* May 3.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

The approaching completion of the Panama Canal naturally attracts the attention of the commercial world to the preparations that will be made for the increase of water-borne traffic which will result at the various seaports of the Atlantic, Gulf and Pacific coasts of the United States. The amount of shipping that will be brought to these ports will depend, among other things, upon the facilities which will be provided at the steamship terminals for the rapid and cheap transhipment of freight from the steamships to the railroads and to local destinations. The single operation of handling miscellaneous freight at the terminals forms such an important item in the cost of transportation that it should be given first consideration in any steps towards the improvement of terminal facilities. It is generally recognized that the terminal facilities at most American ports are badly in need of modernizing. The slow and costly method of doing this work by manual labor is still adhered to in the majority of cases in spite of the fact that in recent years nearly every important foreign port has spent large sums of money for the installation of extensive systems of mechanical appliances for handling freight. Since the ports on the Great Lakes have developed such highly efficient systems for handling bulk cargo it is not to be supposed that the seaports will longer delay action in improving the handling of general cargo at their steamship terminals. The seaports do not stand alone in this need, however, for the opening of the Panama Canal is expected to have an important influence on the development of marine transportation on the Mississippi River and its tributaries. Here the need of adequite river terminals and suitable connection with railroad traffic is even more imperative in order to reap the benefits from the work which has already been done in improving these inland waterways. Every port, of course, whether on the coast or on an inland waterway, presents its own problems according to its natural resoruces, but they all have this in common—the handling of miscellaneous freight must be accomplished in some more rapid and economical way than the present practice of depending almost entirely upon manual labor.

It is a common complaint among marine engineers that accurate data regarding the performance of marine machinery, except in the case of naval vessels, are difficult, if not impossible, to obtain. In only rare instances are complete tests of the main engines and boilers made in regular service. When a trial trip is undertaken it usually consists of nothing more than the necessary run from the builders' yard to the owners' pier and the only data available are the perfunctory statements that "the engines worked very satisfactorily" and that "the ship attained its contract speed, or a little better." The main engines may be indicated or the shaft horsepower measured if turbines are installed, and a fairly accurate estimate of the power developed ascertained, but for any accurate figures as to the amount of fuel consumed, the quantity of water evaporated per pound of fuel or per square foot of heating surface or the amount of steam used by the main engines and auxiliaries under various conditions, the engineer must depend more or less upon guesswork based upon the average performance of the vessel for a season's run as indicated by the company's fuel bills and other approximations. Where oil fuel is used the engineer has an opportunity to determine with a very considerable degree of accuracy the actual amount of fuel used, providing the measurements of the contents of the oil bunkers are carefully made. A most useful and accurate method of doing this is explained in an article which we are publishing in this and the following issue. The author, whose experience along these lines enables him to discuss the subject with authority, explains the probable causes of inaccuracies in the determination of such figures and outlines the method of procedure for accurately obtaining them. With the increasing use of oil for fuel in the merchant marine service many of our readers will no doubt have an opportunity to apply this method and secure some information as to fuel economy that can be looked upon as reliable.

Improved Engineering Specialties for the Marine Field

The Oxy-Blaugas System

What is claimed to be a great advance in the progress of the metal welding and cutting industry has been brought about recently through the introduction of the Oxy-Blaugas system by the Atlantic Blaugas Company, of New York. While this system is operated in practically the same manner as the various oxy-acetylene systems, it has numerous advantages from a commercial point of view. Blaugas, which is used in combination with oxygen in the usual manner, is a compressed liquefied distillation gas produced from mineral oils. In the process of its manufacture the gas is reduced to 1/400 of its volume and all poisons and impurities are removed. One cubic foot of expanded Blaugas contains 1,800

British thermal units. Blaugas is especially well adapted for welding, cutting and brazing purposes on account of its exceptionally high heat value, its very narrow explosive range and its unparalleled transportability. The explosive range of Blaugas is only 4 percent, this being the narrowest range of any known commercial gas.

Blaugas is sold by the pound in steel cylinders, 43 inches high and 8 inches in diameter. Cylinders contain an average of 20 pounds of liquid Blaugas, which is sold at a standard price of 10 cents (5 pence) per pound. Each liquid pound expands into 12½ cubic feet of free gas, and from the above it may be figured that each cylinder contains approximately 250 cubic feet of gas at a price of only 4/5 cent (.4 pence) per cubic foot.

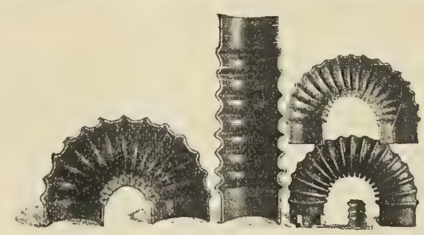
Taking into consideration the extremely low price of Blaugas, and the fact that amazingly large quantities are contained in small, easily-handled bottles, it may readily be seen that this system of metal welding and cutting is exceptionally economical.

A very important advantage of Oxy-Blaugas welding over the other autogenous welding systems is that the flame of the Oxy-Blaugas torch is much broader than that of the torches of the other systems, thereby insuring a greater and more uniformly heated area of the metal to be welded and preventing the high tension in the welded material. It is a well-established fact that, through the great differences of temperature produced in the material to be welded, a tension is created within the immediate area covered by the flame, and if the metal is subjected to tensile strength test it will frequently break directly beyond the weld, which disadvantage is greatly lessened with the Oxy-Blaugas system.

Besides being a most desirable medium for all welding, brazing and metal-cutting work, Blaugas is also used very largely for lighting, cooking and heating in homes, yachts, vessels, etc.

Elastic Corrugated Tubes

O. N. Beck, 11 Queen Victoria street, London, E. C., has on the market a special line of corrugated tubes, made of either seamless steel tubes or, in larger sizes, wrought iron tubes welded with overlapping seams and rerolled for use in pipe lines where bends of small radii or expansion and vibration joints are needed. The tubes are also useful for increasing the heating surface of boiler and superheater tubes, as well as relieving the strain on boiler heads and increasing

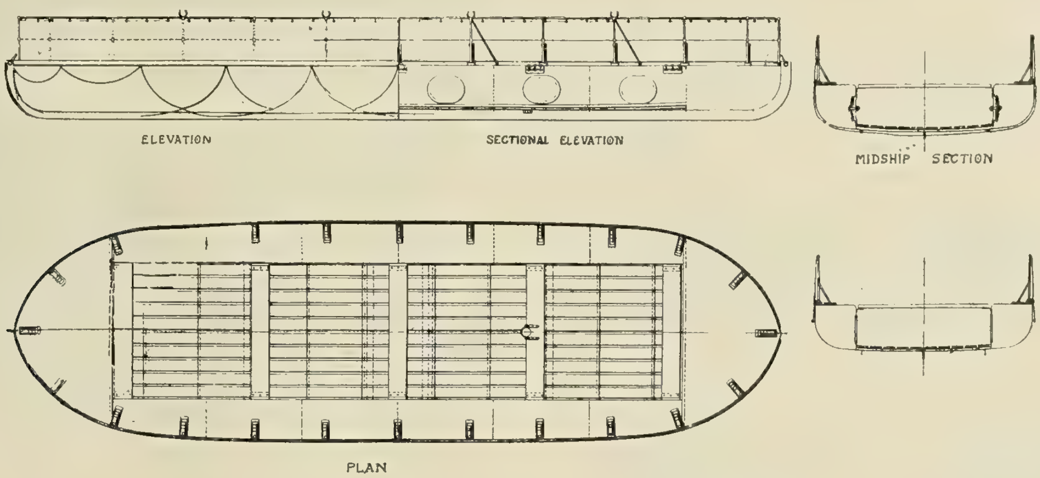


the whirling motion of steam. The peculiar method of manufacture by special machines of registered design ensures an absolutely uniform thickness of metal in all parts of the tubes. The tubes are manufactured of an inside diameter of from 35 to 450 millimeters. The inside diameters and thicknesses correspond to the standard sizes of boiler tubes. The process of manufacture is such that, after pressing out the corrugations which always arch outwards, the pipe retains its exact original internal diameter throughout, the corrugations being parallel and not spiral, as in the ordinary well-known flexible tubing, affording therefore a certain amount of axial elasticity.

It is interesting to make a comparison between the ordinary loop joint and an expansion joint made of corrugated tubing. The maximum compensating capacity of the well-known type of expansion bend of a bore of, say, 10 inches, length of 10 feet and a projection of 10 feet, is 2 inches, while a bend made of corrugated tubing will, with a length of 4 feet 7 inches and a projection of 5 feet 3 inches, take up an expansion of 5½ inches. Thus a pipe range in which an expansion of 5½ inches has to be accommodated would require three ordinary loop joints of a total length of 86 feet, or only one piece of corrugated tubing of about 15 feet. Apart from the considerable amount of space taken up by these huge bends, which, of course, is not always available, the corrugated joint not only ensures a smaller degree of cooling, owing to the very considerably shorter length, but also entirely obviates all strain on the flanges and connections.

Seamless Steel Semi-Folding Boat

The boat illustrated is designed by the Seamless Steel Boat Company, Ltd., Wakefield, to retain the special features for which the standard seamless steel lifeboat is noted, *i. e.*, strength, durability and seaworthiness, absence of leaking, and yet at the same time occupy much less room on the ship's deck than the ordinary boat. The lower part of the hull up to beyond the load waterline is made in the usual manner of seamless steel boats; each side consisting of one sheet of galvanized steel riveted to a T-bulb section mild steel keel bar; the upper portion of waterproof canvas forms a shield from the wind and spray, and is not an essential portion of the floating capabilities of the boat; the steel hull being completely buoyant and seaworthy in itself. The canvas is supported by galvanized iron stanchions, which hinge down upon the seats, and can be easily raised and are automatically held in position when upright.

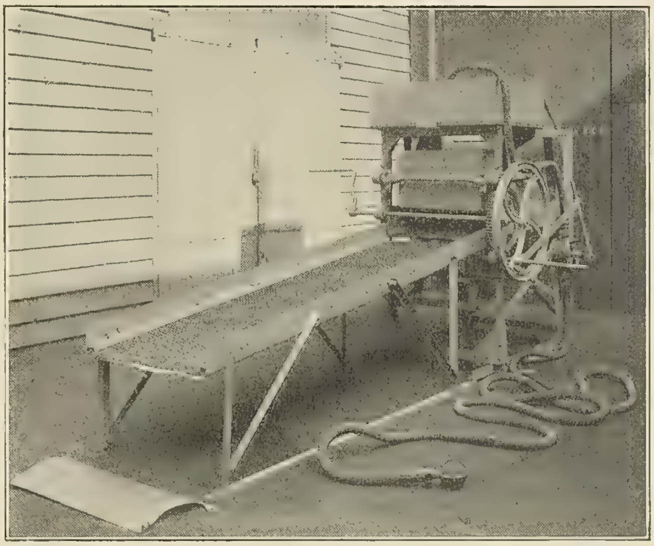


A great advantage claimed for the seamless steel boats is that the method of construction permits the air-tight cases (or buoyancy chambers) to be built into the hull itself, serving the double purpose of strengthening the hull and of floating the boat and the passengers even when the boat is full of water. The method of constructing these tanks is, briefly, as follows: About 3½ feet from each end of the boat a watertight steel bulkhead is fitted, on top of which, reaching right to the end, is fitted a watertight steel deck, thus forming the ends of the boat into air-tight chambers of large capacity. Along each side of the boat are fitted steel plates, pressed to such a shape that when riveted to the hull they form continuous air-tight compartments from bulkhead to bulkhead. For further safety, however, these are divided into six separate chambers by means of watertight division plates, the total capacity of the buoyancy chambers being so much that the boat (loaded) would float even if two of them were pierced. Watertight doors are fitted to each compartment to give access for inspection, cleaning or painting, the door being either of the single-bolt fastening type (as shown in upper section), or of the ordinary lid type with set bolts (as shown in lower section). Lifelines are becketed right along the sides, extending to the keel, so that if the boat were floating overturned they would afford a means of clinging to and obtaining a foothold on the bottom of the boat. The alternative section of the boat on the drawing shows bilge keels fitted with hand grips instead of the lifelines along the bottom, as this method may be preferred in some cases.

Seating accommodation is provided for forty passengers, and the boat is capable of carrying at least seventy. Rowlocks are fitted for rowing, with fittings for mast and sail and hooks or slings for lifting on davits.

Improved Alluvial Hand and Power Washing Machines

The alluvial washing machines manufactured by Arthur R. Brown at 54 New Broad street, London, E. C., comprise the following special features: The height to which the material has to be shoveled is very much less than in other machines, and the special jigging action of the boxes is claimed to give a more perfect separation of the particles of gold or other metals that are required to be separated from the gravel. The height is reduced owing to the two boxes being jigged in opposite directions, which allows the material to drop direct from the lower end of the top box to the upper end of the lower box, thus dispensing with the fixed inclined shoot used in other machines to deliver from the top to the bottom box. Another advantage is that the material not only passes over two jigging boxes but passes over as well a stationary sluice box, which has the advantage of not only



giving an extra large area for saving the gold but also enables the tailings to be carried some distance away from the machine.

The machine can be worked by one man working the handle on the fly-wheel, or by two men, and the pump can either be worked separately or from the fly-wheel. In places where it is possible to get horses or mules, it is an advantage to have, in addition to the machine, a horse-gear, arranged to work either one or two machines, thus leaving the man free to shovel the gravel.

The material is shoveled into a hopper at the top of the machine, whence it falls on to a grizzly, where the large

stones are separated out and the fines fall through on the expanded metal and matting on the bottom of the top box. After the fines have been jigged down to the lower end of the top box, they fall on to the upper end of the lower box, and are then jigged in the opposite direction down a sluice box.

Two sets of matting are supplied to each box and sluice box, and one set of expanded metal, also 30 feet of suction and 10 feet of delivery (armored) hose. The shipping weight of each machine is approximately 16 cwts. without the horse-gear. The shipping weight of the horse-gear is approximately 10 cwts.

Dermatine Cup and Ram Rings

Dermatine is a metal which it is claimed will stand more wear and rougher usage than leather, rubber or gutta percha, and it is, therefore, used in the manufacture of many of the articles which formerly were made of these materials. The manufacturers are the Dermatine Company, Ltd., 93 Neate

FIG. 1

FIG. 2

street, London, S. E., and two of the products of this company in which Dermatine is used in greater quantities than any other are belting and hose. A special grade of suction hose, which is manufactured with imbedded spiral wire, is particularly useful for marine work.

Dermatine valves, both flexible and hard, fitted with patent anchor bushes, which add much to the length of the life of valves for air pumps and force pumps, have been described in previous issues of this journal. Dermatine valves are particularly adapted to resisting steam and oil, and are therefore useful for all kinds of pump work. Dermatine has also been applied to the construction of pump cups, as shown in Fig. 1, and its use has been found to increase the life of rings for hydraulic apparatus far beyond the life of leather rings. A special design of Dermatine rings is shown in Fig. 2, which is called the Dermatine hydraulic "U," or ram ring.

Oxy-Acetylene Apparatus for Ship Work

With oxy-acetylene apparatus used for cutting on steel ships, barges and dredges under course of erection, it is claimed that the torch will cut manholes, strainer holes, etc., through the plate at approximately one-eighth the cost and time in which it would be effected by air chippers or other tools. The work can be done anywhere the operator can climb with the torch in his hand; the cut is narrow and smooth and requires practically no subsequent dressing up. Spots of manganese, etc., in the plate, which would dull and break cutting tools, offer little or no resistance to the flame and high-pressure jet of oxygen. Also, in the welding together of angles and building up sections and forms the welding feature of the torch shows a saving also very pronounced. A great advantage of the torch on the work is that it is handled by one man instead of having several men haul large pieces out of a big furnace and striking while the iron it hot, perhaps requiring two or more heats to finish a weld and resting between heats. By the oxy-acetylene method the sections are simply lined up in position, and one operator with the torch and its intense concentrated flame welds up the joint quickly and efficiently, and with no loss of time or handling.

A type of portable plant (Fig. 1), designed especially for welding and cutting in shipyard and similar work, is manu-

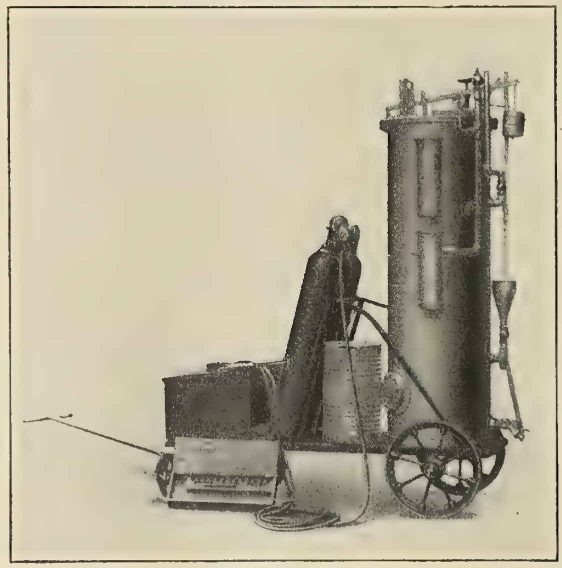


FIG. 1

factured as a part of the regular line of the Alexander Milburn Company, 505-507 West Lombard street, Baltimore, Md. The generator furnished is 50 pounds carbide capacity, automatic in operation, and assures an ample supply of acetylene at a low cost per cubic foot. The oxygen is supplied

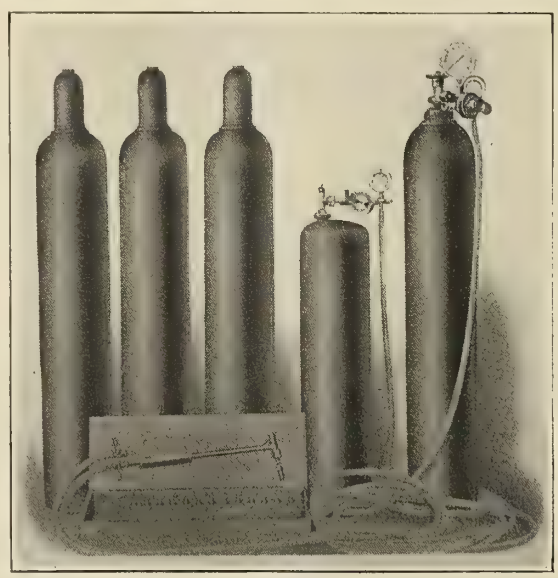


FIG. 2

in any desired quantity in portable cylinders, which can be carried always on hand.

Another equipment, which has been developed principally for wreck trains on railroads, but which should also be in the tool department of every important ship on the sea for emergency repair work, is the Milburn tank storage welding and cutting plant (Fig. 2). The essential parts of this plant consist of a tank of acetylene and a tank of oxygen, with valves, torch, hose, etc., packing into a space 2 feet square by 4 long, while the complete outfit, including a reserve tank of

acetylene and three of oxygen, giving ample supply for a large amount of repairing, takes up very slight space. All tanks as emptied in use are exchangeable for full ones at ports. By the storage tank system the acetylene costs somewhat more per cubic foot than by the generator system, as advocated for ship yards.

Technical Publications

The Lifeboat and Its Story. By Noel T. Methley. Size, 8¾ by 5½ inches. Pages, 318. London: Sidgwick & Jackson, Ltd. Price, 7s. 6d. net.

This is written from the popular standpoint, and the author has taken a great deal of trouble in securing his information from a variety of sources in all parts of the world. The first few chapters are written from the historical point of view, and trace the evolution of the lifeboat from the earliest days to steam and motor-propelled vessels for life-saving. The British lifeboat system is studied, together with the station and its equipment. This is followed by a chapter upon "the lifeboat at work," in which details associated with some big rescues from wrecks are included.

Details of the life-saving service in various countries cover five chapters. "We are a little apt," says the author, "to look at our own well-nigh perfect system and to plume ourselves upon the superior quality of our humanity. It will be quite a surprise to many to find that the same spirit and the same endeavor are world-wide. It is not too much to say that almost every civilized country that needs a maritime life-saving service has done its best to provide one, and in its human efforts it is pretty certain that it has been well supported by the public, for the lifeboat cause everywhere is a popular one."

An interesting chapter on "Freaks and Oddities" is included, which details some of the extraordinary inventions which have been made in the field of life-saving. Another section deals with the rocket and wreck gun, and a concluding chapter compares and contrasts the services of the world. Nearly 70 reproduced photographs illustrate the work and enhance its interest.

The Western Gate. By Patrick H. W. Ross. Size, 5 by 7½ inches. Pages, 153. New York, 1911: Dodd, Mead & Company. Price, 75 cents net.

In this book some novel ideas are enunciated regarding the restoration of the American merchant marine. The principal idea seems to be to establish a free port in that portion of the State of Washington lying west of the Cascade Mountains, and to build up in that section of the country a shipping and shipbuilding center which would be comparable with Glasgow, Belfast, Stettin, Nagasaki and other foreign shipbuilding centers. The author admits that some provision would have to be made for help by Congress to get the necessary ships, and also that the first requisite for building up the merchant marine is to create in the people throughout the country an ardent desire to own ships. The actual process by which this purpose could be accomplished, however, is left to the reader's imagination.

The Steam Engine and Turbine. By Robert C. H. Heck, M. E. Size, 6 by 9 inches. Pages, 631. Illustrations, 401. New York, 1911: D. Van Nostrand Company. Price, $5 net.

Those familiar with the mechanical engineering department of Rutgers College will need no introduction to the author of this work, nor to a portion of its contents, as part of the volume is adapted from a previous book written by the author, entitled "The Steam Engine and Other Steam Motors." The present book is, first of all, a text-book for engineering students, but it is so complete, as far as the consideration of the steam motor is concerned, that it will prove a most valuable addition to any engineering library. The subjects of the generation and impartation of heat, or, in other words, furnaces and boilers, have not been included, as they are properly considered as subjects which should be treated more fully elsewhere. Between the engine and the turbine more space is devoted to the engine, although, as the author states in the preface, the subject matter in the early chapters is applicable to both, while greater attention is purposely given to the former, on account of the greater value for text-book purposes of the more complete information which is available on this subject.

The Twelve Principles of Efficiency. By Harrington Emerson. Size, 5 by 7½ inches. Pages, 423. New York, 1912: *The Engineering Magazine*. Price, $2.

Harrington Emerson is well known to the engineering world from his work in analyzing the operation of industrial organizations and reducing them to a sound basis of efficiency.

Unfortunately, the majority of manufacturers and managers of industrial organizations have not given as much time and study to the question of efficiency as it deserves. Those who have slighted this part of organization work will be well repaid to examine the twelve principles of efficiency as set forth in this volume by Mr. Emerson. Five of these principles are concerned with the relations between men and the other seven with methods or institutions and systems established in either the manufacturing plant or in the operating and distributing company. These principles will be found fundamental and true, so that they may be used as gages to measure the results in existing organizations. The titles of the chapters are suggestive of the factors entering into the question of efficiency. They are as follows, and each represents a single principle: 1. Ideals. 2. Common Sense and Judgment. 3. Competent Counsel. 4. Discipline. 5. A Fair Deal. 6. Reliable, Immediate and Accurate Records. 7. Planning and Despatching. 8. Standards and Schedules. 9. Standardized Conditions. 10. Standardized Operations. 11. Written Standard Practice Instructions. 12. Efficiency Reward.

The Loss of the Steamship Titanic. By Lawrence Beesley. Size, 5 by 7¼ inches. Pages, 301. Illustrations, 5. Boston and New York, 1912: Houghton & Mifflin Company. Price, $1.20 net.

Even though practically every detail regarding the loss of the *Titanic* has been published and republished in the daily press at the time of the accident, many will appreciate the opportunity to obtain a carefully revised, authoritative statement from a cool-headed witness of the disaster. As this account was not written until the investigation of the disaster had been made in Washington, bringing out practically all of the available information that could be obtained, it can be looked upon as the most correct history of the disaster. The story begins with the construction and preparations for the first voyage of the vessel; the departure from Southampton and an account of the voyage up to the night of the collision; then the collision and embarkation in lifeboats and the sinking of the *Titanic*, as seen from a lifeboat, are fully described from the witness's point of view, which is supplemented by an account of the sinking of the *Titantic*, as seen by one of the survivors from her deck; then follows an account of the rescue and return to New York on board the *Carpathia*. The final chapters discuss the lessons taught by the loss of the *Titanic* and some personal impressions of the disaster. Most of the lessons which Mr. Beesley points out with special emphasis are common knowledge, and are fully realized by every one who has read anything about the disaster. Some of them, however, should be submitted to the probe of competent marine experts before any attempt is made to follow out the suggested remedies.

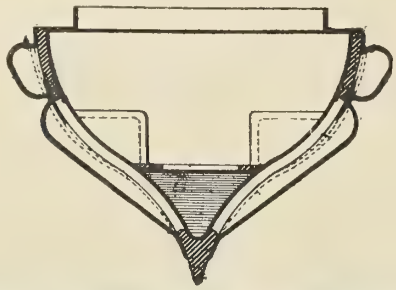
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,010,309. UNSINKABLE BOAT. JOSEPH PASTOREL, OF ASBURY PARK, NEW JERSEY.

Claim 1.—An unsinkable boat comprising a framework or hull of



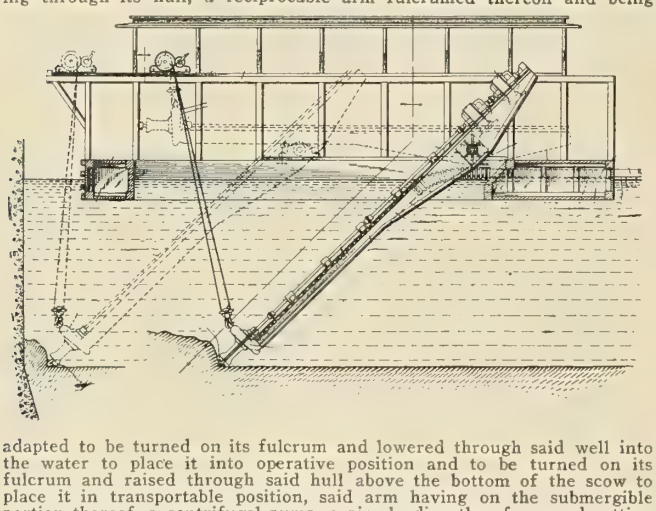
hard rubber, having a number of sheets of air-tight and waterproof material secured thereto on the inside and outside thereof, said sheets forming air compartments which increase the buoyancy of the said boat. Four claims.

1,004,525. GEARING. BENJAMIN BARNES, OF ASTON, SOUTH MELBOURNE, VICTORIA, AUSTRALIA.

Claim 1.—Improved speed-reducing gearing for marine steam turbine engines, comprising a driving shaft provided with a friction boss, three comparatively large equidistant friction wheels adapted to be brought in contact with said boss by means of steam pressure, a driven shaft, and reducing gearing for transmitting the power from said friction wheels to the driven shaft. Four claims.

1,019,610. DREDGING APPARATUS. WILLIAM THOMAS DONNELLY, OF BROOKLYN, N. Y.

Claim 2.—A dredging apparatus comprising a scow having a well leading through its hull, a reciprocable arm fulcrumed thereon and being



adapted to be turned on its fulcrum and lowered through said well into the water to place it into operative position and to be turned on its fulcrum and raised through said hull above the bottom of the scow to place it in transportable position, said arm having on the submergible portion thereof, a centrifugal pump, a pipe leading therefrom and cutting means and on the nonsubmergible portion thereof a source of power, and a rotatable shaft directly connecting the rotable elements of the source of power and the pump and having the said cutting means thereon adjacent the inlet of the pump. Three claims.

1,021,408. BOAT STEERING AND PROPELLING DEVICE. JULIUS E. HASCHKE, OF CHICAGO, ILLINOIS, ASSIGNOR TO JEWEL ELECTRIC CO., OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

Claim 1.—A motor having a housing and a vertical drive shaft, said motor housing providing a jacket-attaching part concentric with said shaft, a propeller structure having a gear and a housing therefor, said gear-housing providing a jacket-attaching part, a vertical shaft at one end engaging said vertical motor shaft and at the other end having a worm engaging said propeller gear, a jacket surrounding said vertical shaft, engaging said jacket-attaching portions of the motor and gear housings, and supporting said motor and propeller; and a clamp for detachable engagement of a boat and for adjustable engagement of said jacket to vary the height of said jacket and jacket-carried motor and propeller relative to the boat. Three claims.

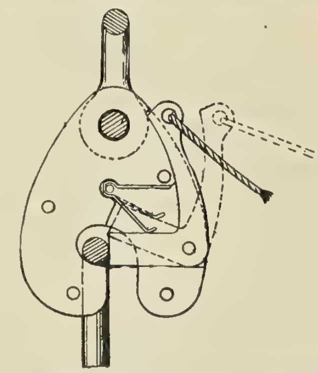
1,021,267. STEERING DEVICE FOR MOTOR-BOATS. NATHANIEL ROE, OF PATCHOGUE, NEW YORK.

Claim 1.—In a steering device, a bracket, a bearing mounted on said bracket and provided with an upwardly projecting shaft, a longitudinally extending shaft journaled in said bearing, a barrel journaled on the first named shaft, and provided with a gearing connection with the second named shaft, a rudder provided with a post, a quadrant carried by said post, and a pinion carried by the barrel and meshing with said quadrant. Three claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

23,323. BOAT-RELEASING HOOKS. J. JORDAN, SYDNEY, N. S.

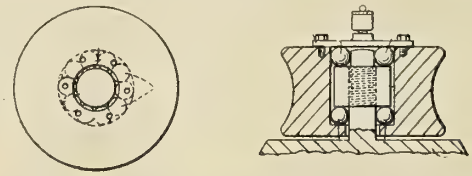
Claim.—The mouth of this hook is closed by one end of a bell crank lever, which acts as a stop and retains the boat ring in position to be



supported by the hook until the other end of the crank is pulled outward, say by means of a line or cord, to raise the stop and so to permit the ring to slide out of the hook.

23,322. BOLLARDS, FAIRLEADS AND THE LIKE. A. OKA, JAPAN.

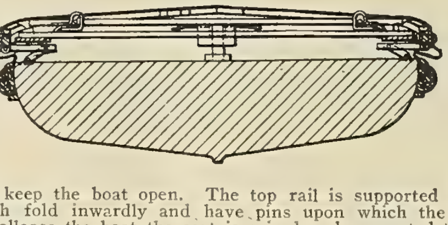
Claim.—By this invention two series of balls are arranged around a fixed pin, and between the latter and the sheave, and abut against a



collar on the pin between the two sets of balls and against the end flanges, or covers, of the sheave. The fixed pin may be integral with the base or in a separate piece and in a modification the collar on it is made readily detachable, for example, by screwing.

12,652. COLLAPSIBLE BOATS. V. ENGELHARDT, COPENHAGEN.

Claim.—Relates to a boat of the kind in which a buoyant lower part carries a top rail on a number of struts which connect the rail with the lower structure in such a way that the rail can be raised or lowered to expand or contract the boat. The present invention provides cross and side seats that are secured in place after the boat is expanded and



which then keep the boat open. The top rail is supported by jointed struts, which fold inwardly and have pins upon which the rigid seat rests. To collapse the boat the seat is raised and supported temporarily on cross-bars by hooks. When the struts fold, the hooks are automatically released and the parts lie compactly together.

12,311. MARINE LIGHTS. T. MANWELL, LONDON.

Claim.—This invention relates to improvements in marine lights of the class in which phosphide of calcium, coming into contact with water, produces flame and smoke. The inner chamber is filled with phosphide of calcium and the outer chamber sealed. When the seal, shown at the top, is broken, and the apparatus comes in contact with water, water enters the outer chamber above, passes into the inner chamber through the slot or perforations on the lower edge of the inner chamber, and comes into contact with the material contained therein. The gas then generated passes out into the outer chamber and up through the water, igniting as it comes into contact with the air.

International Marine Engineering

SEPTEMBER, 1912

World's Largest Bulk Freighters Built on the Great Lakes

The freight steamers, *Col. James M. Schoonmaker* and *William P. Snyder, Jr.*, recently built by the Great Lakes Engineering Works, Detroit, Mich., for the Shenango Steamship & Transportation Company, Pittsburg, Pa., are not only the largest bulk freight steamers on the Great Lakes, but they are the largest vessels in the world designed exclusively for carrying freight in bulk.

While these steamers are by no means passenger boats, and no one is carried as a passenger unless specially invited as a guest by the owners of the ships, nevertheless there are provided in the forward deck house for such guests luxurious accommodations which rival the appointments of such magnificent transatlantic express steamships as the *Lusitania* and *Olympic*. The principal dimensions of the vessels are as follows:

Length over all	617 feet.
Length on keel	597 feet.
Beam, molded	64 feet.
Depth, molded	33 feet.
Deadweight carrying capacity at 20-foot draft	13,200 tons.
Water ballast capacity	9,400 tons.
Gross tonnage	15,161
Net tonnage	16,980

The extraordinary development in the construction of Great Lakes bulk freighters in recent years is well known to shipbuilders throughout the world. As has been the custom in recent ships of this type, the hold in these ships is practically an unbroken sweep right forward except for two division bulkheads, almost all of the entire deck being given up to hatches. The hull is of arched girder construction, the cargo hold being divided into three compartments. Hopper sides are carried throughout the hold in a prolonged slope from the tank top to the main deck, forming side tanks 12 feet wide at the bottom and 5 feet wide at the top. It will be seen that notwithstanding the added beam, due to the hopper tanks, the cargo is quite accessible to the unloading machines, owing to the manner in which the side tanks are shaped, confining the cargo easily within the reach of the self-filling buckets, used for unloading bulk cargo, thus entirely eliminatinating hand shoveling.

Water ballast is carried in the side tanks and in the double bottom, making a total water ballast capacity of 9,400 gross tons. The double bottom is 6 feet deep.

The cargo hatches, which take almost all of the main deck, number thirty-five in all. They are 54 feet wide and 9 feet long, fore and aft. The hatch covers, which are of the steel telescopic type, fitted with steel fasteners, are operated by

FIG. 1.—GREAT LAKES BULK FREIGHT STEAMER COL. JAMES M. SCHOONMAKER

wire cables running through portable tripods on deck and fixed cleats in the butt straps, power being supplied by the deck engines.

In construction these steamers are unusually staunch; two extra longitudinal girders have been fitted on the turn of the bilge in the water bottom to secure additional strength. All deck beams run fore and aft, and are 13 inches deep with a 4½-inch flange ⅞ inch thick. All the frames are joggled, thus eliminating the use of liners back of the shell plating. Screen bulkheads are built on the box girder system.

The grate area, with grate bars about 5 feet long, is 55 square feet. Thus the ratio of heating surface to grate area is 47.05 to 1. The draft area through the tubes is 13.28 square feet, thus making the ratio of grate area to draft area 4.14 to 1. The main steam pipe leading from the boilers to the main engine is 8 inches diameter, the main stop valves 6 inches diameter and the auxiliary stop valves 4 inches diameter.

The propelling machinery consists of a vertical inverted quadruple expansion engine, with cylinders 22¾ inches, 33¼

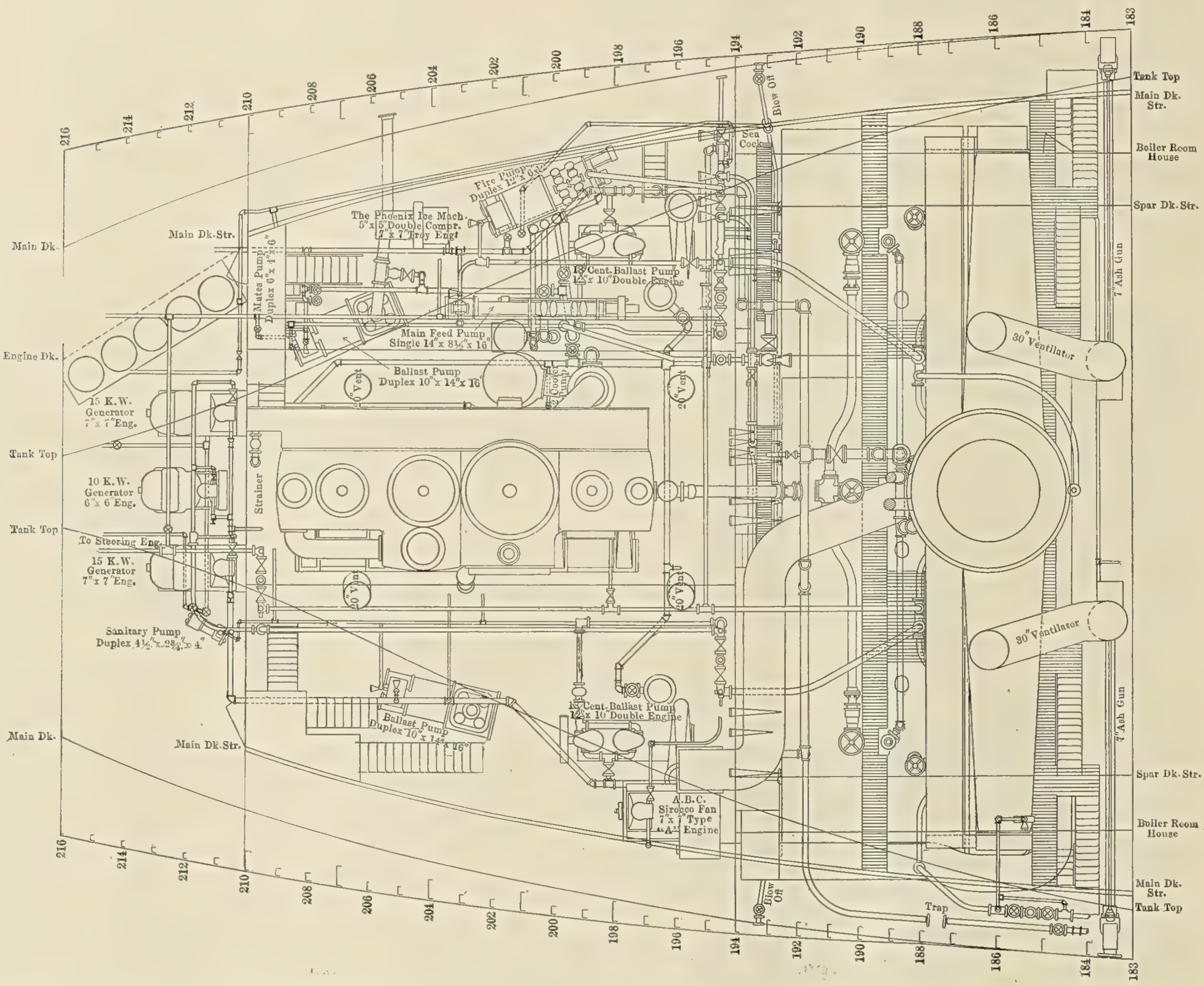


FIG. 2.—PLAN THROUGH MACHINERY SPACE

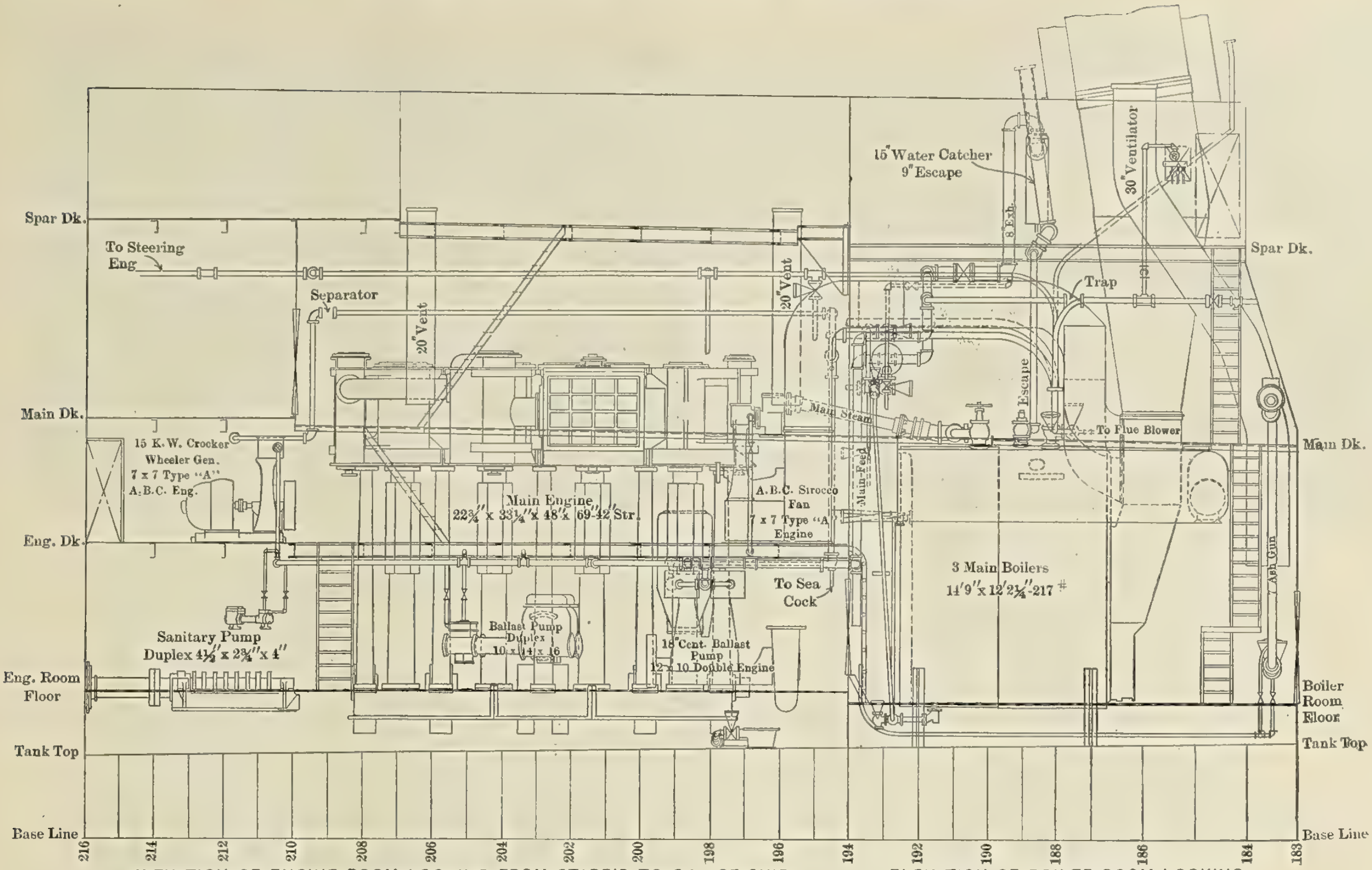
Propelling Machinery

Steam for the propelling machinery and auxiliaries is provided by three Scotch boilers, 14 feet 9 inches mean diameter, 12 feet 2¼ inches long over all. Each boiler has three corrugated furnaces, 44 inches inside diameter 0.64 inch thick, leading to separate combustion chambers. The safe working pressure allowed is 216 pounds to the square inch. The shell plating of the boilers is 1.6 inches thick. The total heating surface of each boiler is 2,596 square feet, divided as follows:

	Square Feet
Tubes	2,211
Furnaces	140
Combustion chambers	245

inches, 48 inches and 69 inches diameters, with a common stroke of 42 inches. The estimated horsepower of this engine, at about 90 revolutions per minute, is 2,600.

The high-pressure cylinder is placed forward and the first intermediate cylinder aft. The low-pressure cylinder adjoins the high-pressure cylinder, with the second intermediate installed aft of the low-pressure. The high and intermediate cylinders are fitted with piston valves, and the low-pressure cylinder with a double-ported slide valve. The high-pressure and first intermediate-pressure pistons have deep, removable followers, and the second intermediate and low-pressure pistons have special metal packing rings. The piston rods are 5½ inches diameter, fitted into annealed steel crossheads



ELEVATION OF ENGINE ROOM LOOKING FROM STARB'D TO C.L. OF SHIP · ELEVATION OF BOILER ROOM LOOKING FROM STARB'D SIDE TO PORT

FIG. 3.—LONGITUDINAL SECTION THROUGH MACHINERY SPACE

having brass shoes, both for going ahead and astern. The connecting rods are 9 feet long between centers, with brass boxes on top and babbitted cast steel boxes at the lower end. The connecting rods are 5¼ inches diameter at the top and 6½ inches diameter at the bottom. All valves are operated with Stevenson link motion, the low-pressure and second intermediate being operated through rocker arms. Metallic packing is fitted on all valve stems and piston rods. All valves are of ample area, and are accessible for quick overhauling. The crankshaft, which is of the built-up type, with cast steel slabs shrunk on, is 13½ inches diameter, supported in six babbitted journals, two 18 inches and two 22 inches and two 11 inches long. The crankpins are 13½ inches by 12 inches. The thrust bearing is braced to the bed-plate, and has eight driving collars, giving an average working pressure of 40 pounds per square inch.

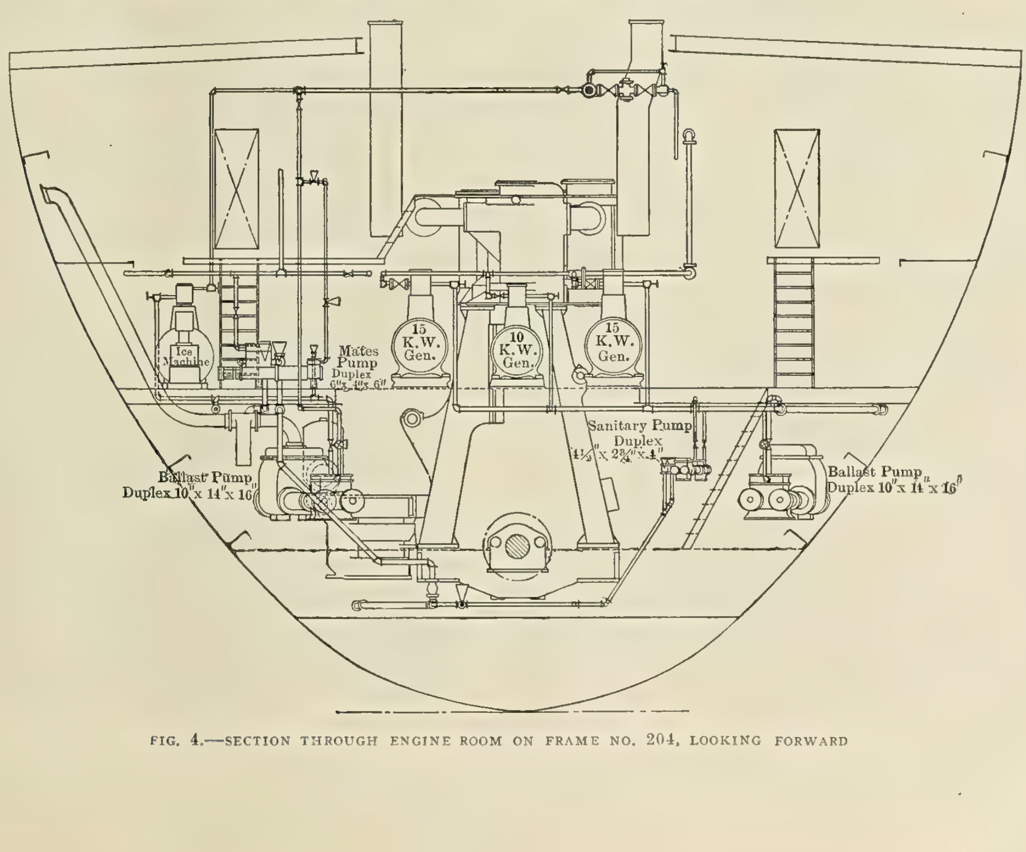


FIG. 4.—SECTION THROUGH ENGINE ROOM ON FRAME NO. 204, LOOKING FORWARD

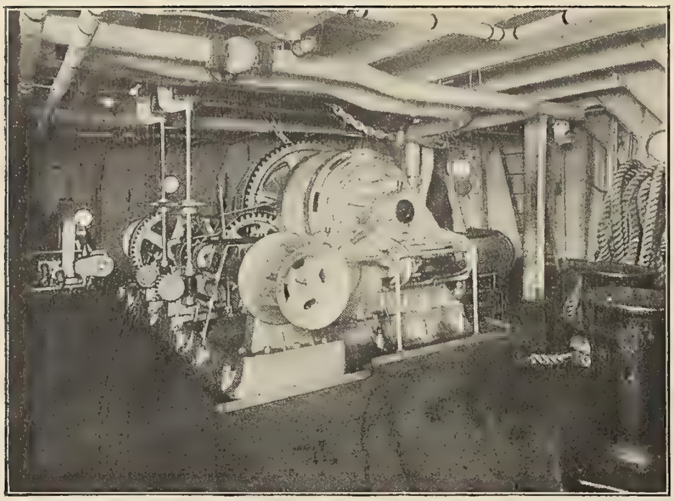


FIG. 5.—WINDLASS ROOM

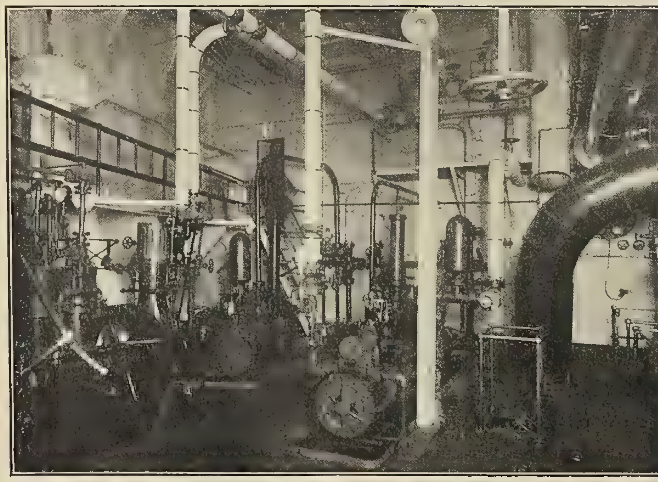


FIG. 7.—PORT SIDE OF ENGINE ROOM AT WORKING DECK, SHOWING MAIN FEED AND FIRE PUMPS AND REFRIGERATING MACHINERY

The outboard shaft is 13½ inches diameter, enlarged at the stern bearing to 15 inches. This bearing is 4 feet 6 inches long, lined with lignum vitæ.

The propeller is of the sectional type, built of semi-steel, 15 feet 9 inches diameter, with a pitch of 13 feet 9 inches and a developed area of 91 square feet.

Auxiliaries

To handle the immense water ballast capacity of the ships two 18-inch centrifugal pumps are provided, direct connected to two 12-inch by 10-inch enclosed double engines, and two 10-inch by 14-inch by 16-inch reciprocating pumps are located in the lower engine room, conveniently connected to the ballast header and so arranged as to pump in and out of the side tanks and double bottom.

These pumps are connected to each compartment by separate suction and filling pipes 9 inches diameter. Stuffing-boxes are provided where these pipes pass through watertight bulkheads. With this arrangement the different compartments can be filled or emptied singly or all together by either or both pumps. One valve is put in each ballast pump suction at the end of a manifold. Two filling valves, 18 inches in diameter, are located below the light waterline and the pumps discharge overboard above the main deck. There are provided one 8-inch seacock in the fore peak, two 6-inch valves between the fore peak and the forward compartment of the double bottom on each side of the center keelson, and two 6-inch valves between the fore peak and the forward compartment of the hold; two 6-inch suctions are provided from the aft hold to the manifold, with valves and padlocks for locking. The suction ends of ballast pipes are led close to the center keelson on each side, and brass plugs are fitted on all drain and ballast piping at the after end.

The main air pump is driven from the low-pressure crosshead. It is double acting and has a diameter of 30 inches and a stroke of 14 inches. The condenser is of the jet type, 36 inches in diameter by 6 feet 3 inches long. A double-turning engine is provided for the main engine, which is 4½ inches by

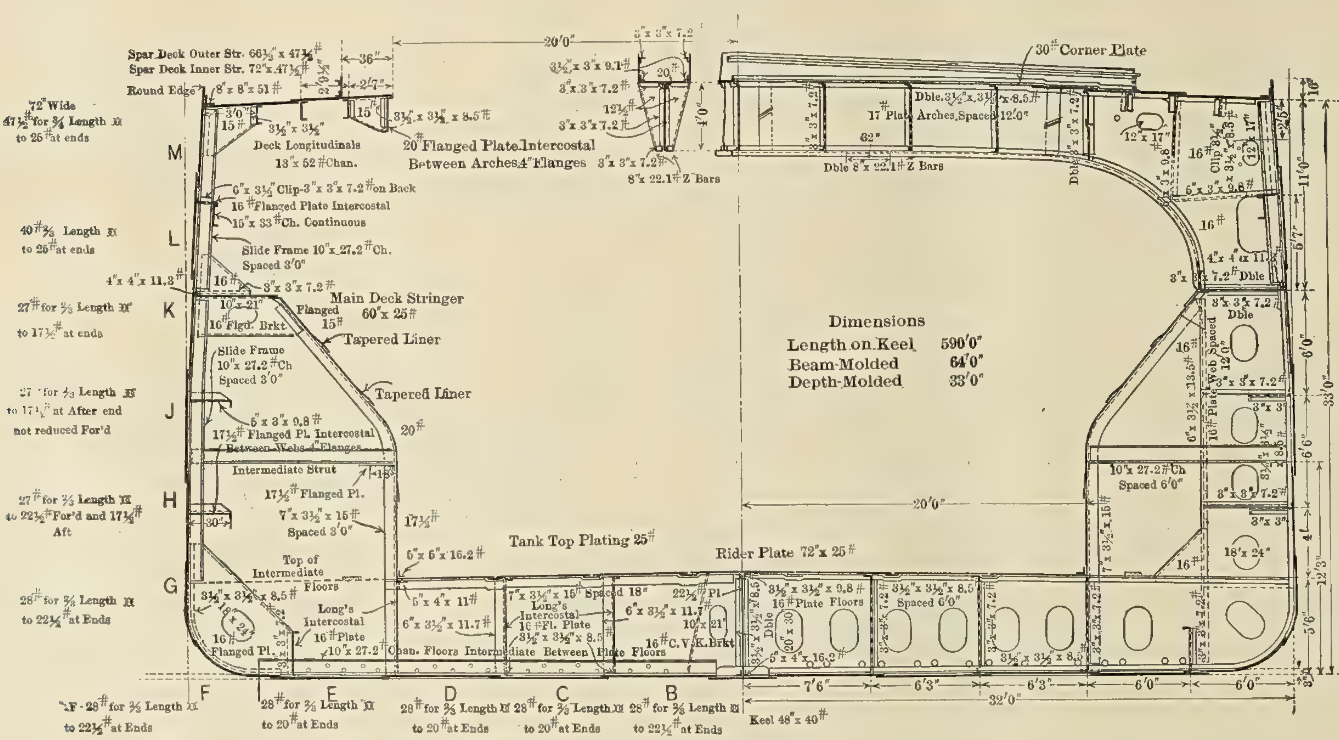


FIG. 6.—MIDSHIP SECTION

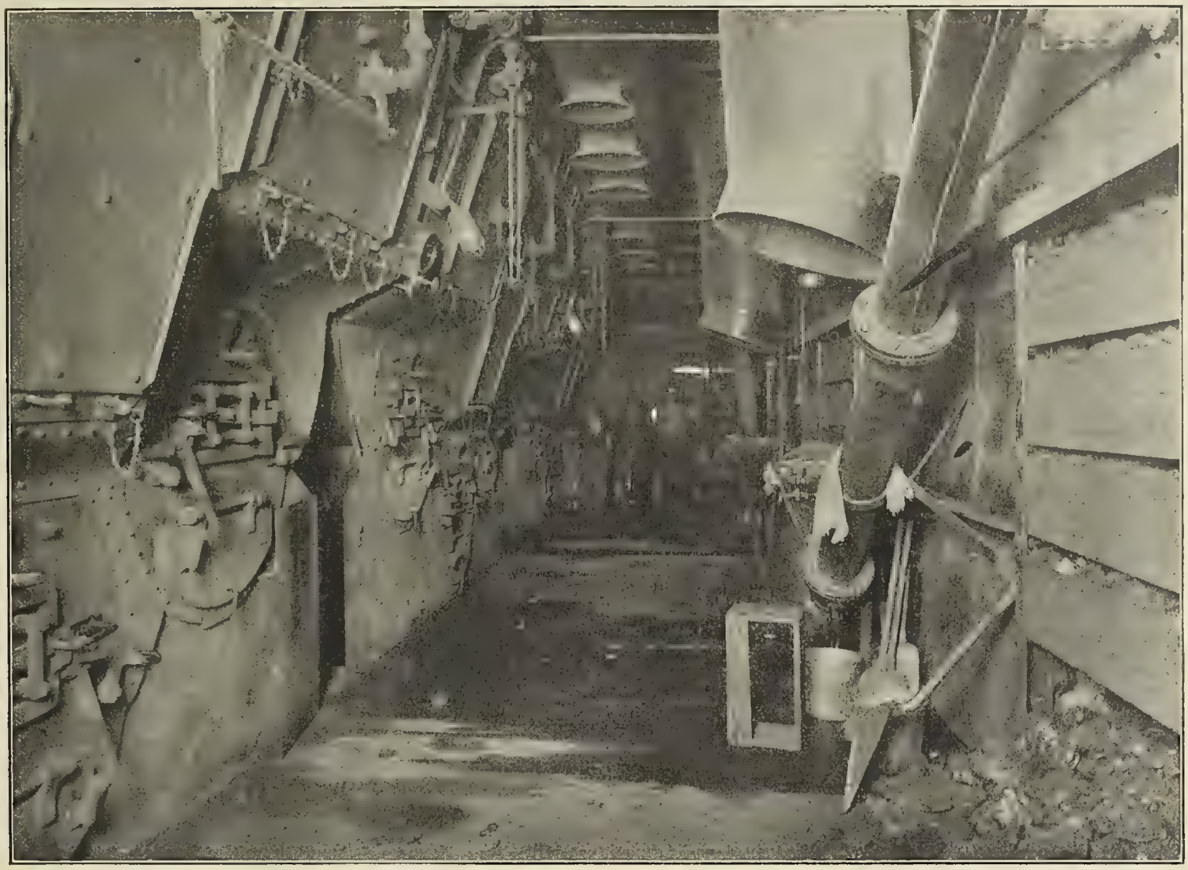


FIG. 8.—FIRE ROOM

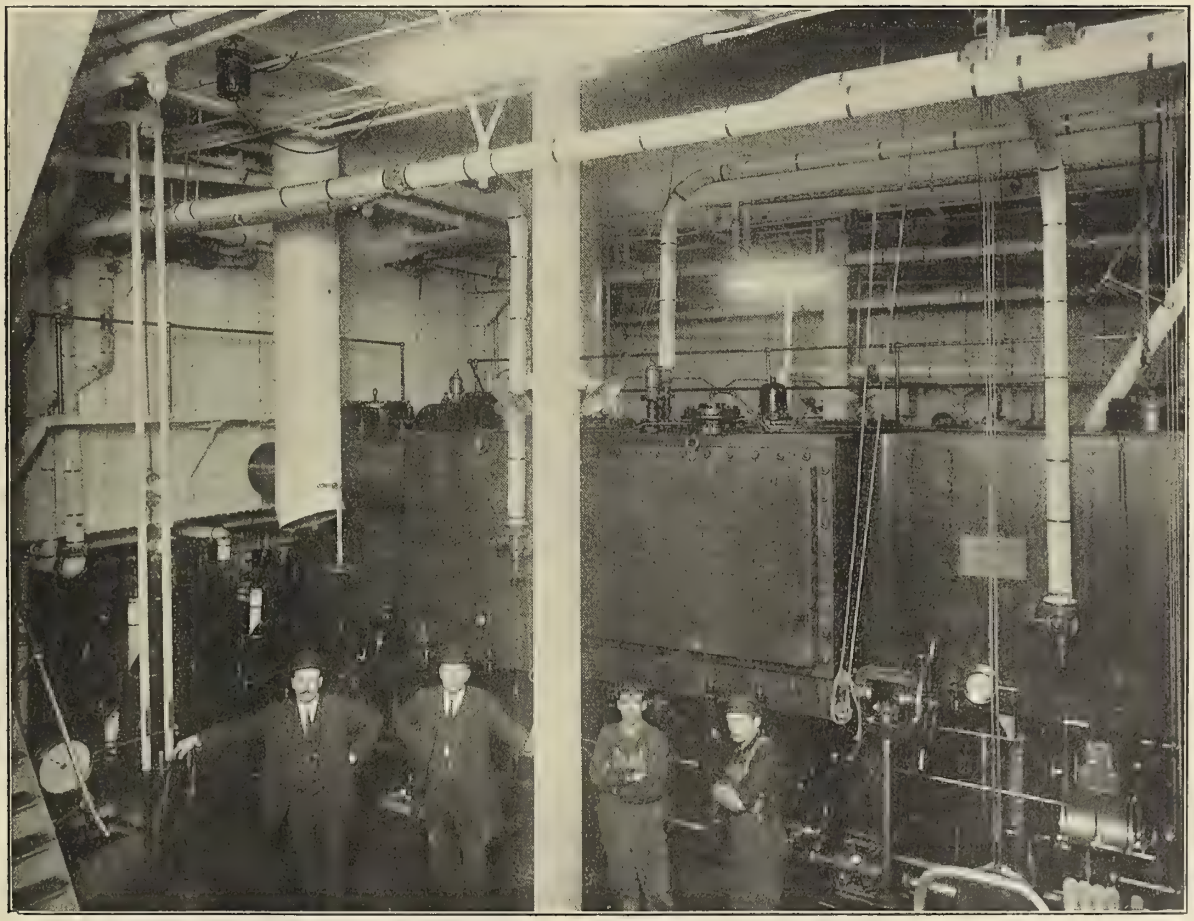


FIG. 9.—STARBOARD SIDE OF ENGINE ROOM AT WORKING DECK

FIG. 10.—GUEST'S STATEROOM

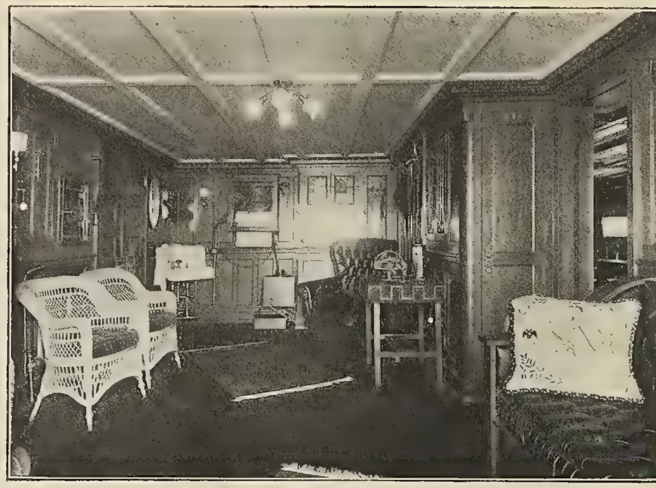


FIG. 12.—CAPTAIN'S QUARTERS, LOOKING TO PORT

6 inches. A direct-connected reverse cylinder, 10 inches diameter by 24 inches stroke, is also installed.

The first item of interest in the deck machinery is the steering gear, which in these ships is a type which represents the latest development of the Great Lakes Engineering Works in this direction. The steering gear is in duplicate, with two wheel stands in the pilot house forward, with transmission gear on each side of the steamer, leading aft to two 9-inch by 9-inch steering engines located on the fantail and connected direct to a cast steel quadrant on the rudder stock.

To handle the mooring cables six engines are installed—four on deck, one aft the cabin and one in the windlass room forward. The deck engines also handle the telescopic hatch covers. There is one windlass aft on the fantail for handling a 3,500-pound anchor and one windlass forward for handling two 4,000-pound anchors.

The engine auxiliaries include a feed pump, 14 inches by 8½ inches by 18 inches; a fire pump, 12 inches by 6 inches by 12 inches, and two duplex pumps, 6 inches by 4 inches by 4 inches, for sanitary purposes. The sanitary system of the steamers is claimed to be the most complete on the Lakes, the tanks for this purpose holding 50 tons of water. A Sirocco fan, 48 inches diameter, driven by a 7-inch by 7-inch type A engine, is fitted for positive-heated forced draft. The electric lighting plant consists of two 15-kilowatt Crocker-Wheeler generators, driven by a 7-inch by 7-inch type A B C engine, and one 10-kilowatt generator of the same make driven by a 6-inch by 6-inch type A B C engine. The feed-water is heated by a Schutte & Köerting special No. 9 feed-water heater, and a Macomb strainer is installed.

FIG. 11.—OBSERVATION ROOM

There does not appear to be any auxiliary apparatus lacking in these ships which would tend to insure safety and convenience in operation. For instance, there is an electric helm indicator in the wheel house, operated by a rheostat connected to the rudder stock, showing the officer in charge the position of the rudder at all times. There is also a simple little device, which is an indicator showing whether the engine is going ahead or astern. This apparatus is installed in addition

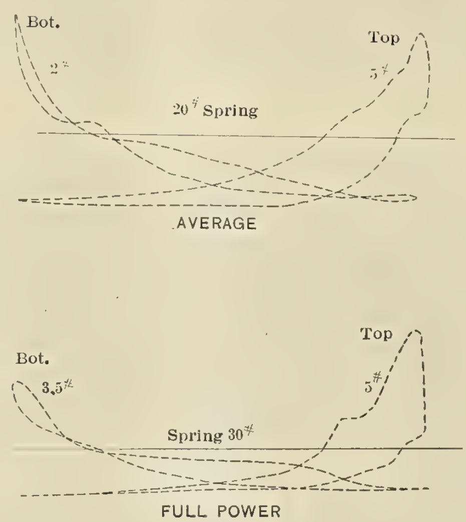


FIG. 13.—AIR-PUMP CARDS

to the usual engine telegraph of the Great Lakes type. There is an electric whistle device to sound signals as they are required as well as to time them automatically during fogs. There is also an emergency alarm, which can be sounded from the pilot house in all departments of the vessel. The telephone service consists of independent lines from the pilot house to the engine room and from the captain's and passengers' quarters to the galley. In the captain's quarters there is a recording compass providing an infallible record of everything that occurs in the wheel house at all hours. A powerful wireless telegraph outfit has been installed. Altogether these ships would appear to have on board every device that human ingenuity has provided to insure safe navigation.

Passenger Accommodations

As stated at the beginning of this article these vessels are bulk freight steamers and are not passenger boats, although luxurious quarters have been provided for a limited number

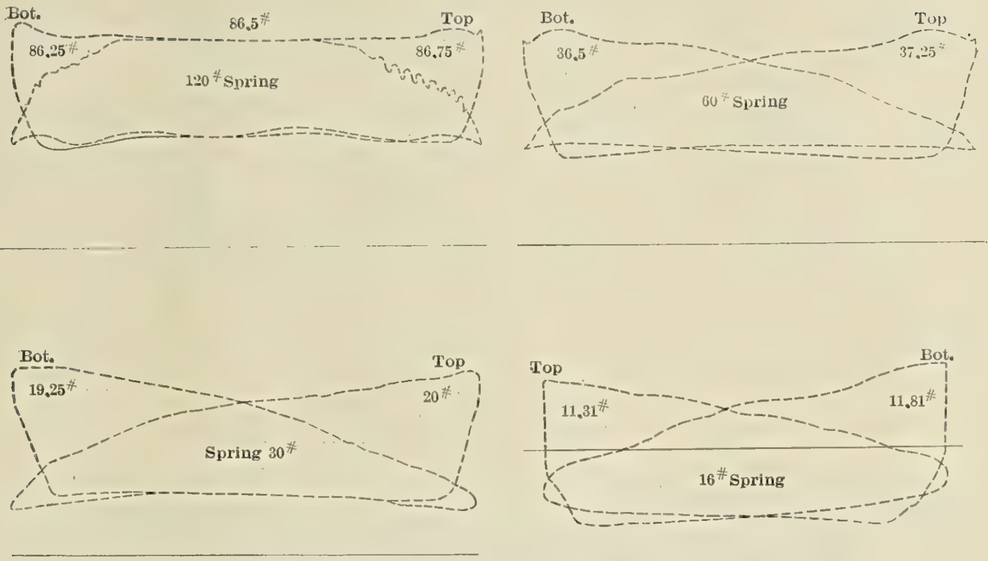


FIG. 14.—SET OF INDICATOR CARDS TAKEN ON LAKE SUPERIOR TRIAL, NOVEMBER 9

of guests. These quarters are unique and distinctive. The entire deck house forward is given over to them.

On the spar deck the deck house is divided by a wide corridor leading directly into a grill room, which extends the full width of the ship. The effect as one enters this hall is quite impressive, as it is produced not only from the appointments of the hall itself, with its ceiling lights and furnishings of fumed oak and Spanish leather, but from the vista it gives of the grill room with its tiled flooring, tiled mantle and electric fireplace.

The quarters for the captain and his guests occupy the space on both the starboard and port sides of this hall. They consist of eight rooms, singly and *en suite,* all finished in white enamel, the furniture being of mahogany with the exception of the beds, which are of brass. Each stateroom is provided with a private bath and shower.

The grill room itself, which is forward of the main hall and staterooms, presents a pleasing effect, with its dull red tile and fumed oak furnishings. The sideboard and china closets are built of fumed oak, with tables and chairs to match. As this room is located as far forward on the spar deck as possible, it is lighted by a dome skylight, which pierces the forecastle deck.

A stairway leads from the corridor on the spar deck to a small hall on the forecastle deck, from which the observation room is approached. In keeping with the general scheme of decoration the observation room is finished in fumed oak with Spanish leather, and is equipped with writing tables, chairs and a built-in settee of splendid proportions, amidships, on the after side of the room. A feature of this room is a Victrola, finished in wood to harmonize with the furniture.

The owner's quarters are on the port side of the forecastle deck immediately aft of the observation room. These quarters consist of one bedroom and a bath room. The captain's quarters are on the starboard side aft of the observation room. A stairway leads from the captain's room to the smoking room or lounge, which is superimposed upon the observation room. This might be called the passengers' pilot house, as it occupies the space usually employed by the pilot house on a freighter. Superimposed on the lounge is the enclosed pilot house.

The cooking for the grill room forward is by electricity,

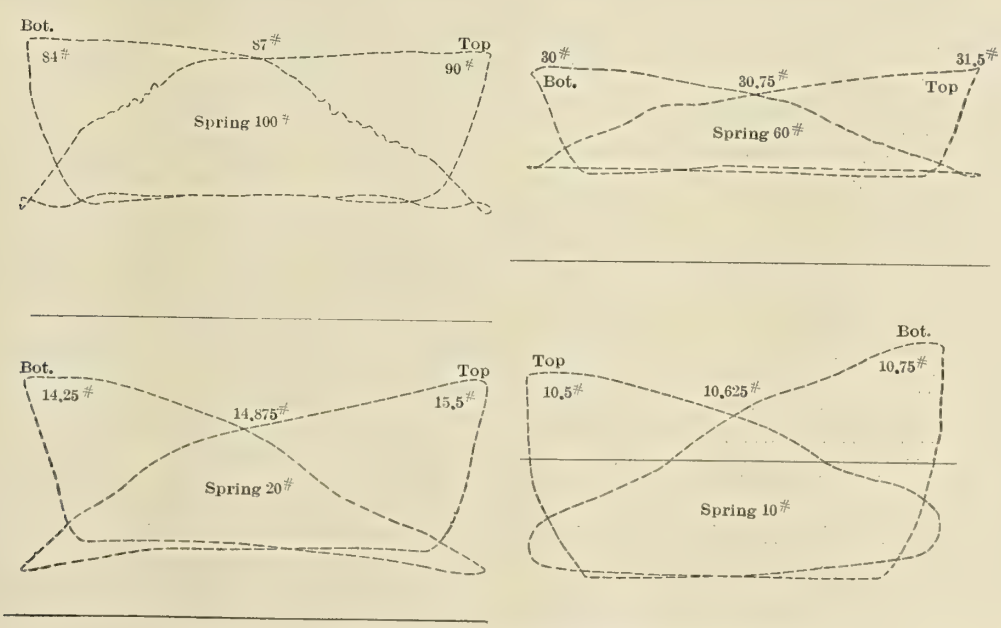


FIG. 15.—SET OF INDICATOR CARDS TAKEN ON LAKE HURON TRIAL, NOVEMBER 8

the galley being on the main deck beneath the passenger quarters, the service being accomplished by a dumbwaiter. An electric stove and steam tables are installed in the galley, while the stores are protected by refrigeration, the ice machine, built by the Phœnix Ice Machine Company, being located in the dunnage room immediately forward of the galley. In this refrigerating system coils of extra strong pipe are placed in the boxes, and liquid anhydrous ammonia is evaporated within them at a very low temperature. In evaporating the ammonia takes up the heat. Brine tanks of ample capacity are provided to maintain an equality of temperature when the plant is not running. This system also provides for making ice for table use in suitable-sized molds.

The dunnage room on these ships will be "a thing of joy" to an orderly mate, as it is quite different from the old-style, inconvenient and disorderly dunnage room found on the majority of freight steamers. The dunnage room extends the full width of the ship, is spacious, light and airy, with a place for everything, and it can easily be observed that everything is in its place.

Great care was taken in the design of the crew's quarters. The first and second mate are housed on the forecastle deck directly aft of the owner's quarters. These rooms are provided with a shower. The forward crew is housed on the main deck directly underneath the passenger quarters, and these accommodations are supplied with all modern conveniences. The after crew, including the deck hands, have ample quarters on the spar deck aft, the rooms being located around the engine room casing. Shower baths are provided in each department with private baths for the chief and first and second engineers. All rooms on the boat are provided with an electric fan, and a drying room is also provided aft of the boilers.

The after end of the deck house is given over to the private dining room for the guests. The crew's dining room is also located on this deck, the private dining room being on the starboard side and the crew's dining room on the port side.

A complete outfit of lifeboats and rafts ample for the full number of crew and passengers is installed.

Trials

A series of trials was carried out on board the *Col. James M. Schoonmaker* by Messrs. Turnbull, Oftedahl and Cameron. The trial trip consisted of a run on Nov. 8 and 9 on Lake Huron, between Thunder Bay Isle and Detour. At the time of the trials the vessel was loaded to a draft of 16 feet 8 inches forward and 17 feet aft. The load was 10,600 tons net, 9,464 tons gross; fuel, 400 tons at Ashtabula. The data from these tests are as follows:

Duration of Test, 2 P. M. to 8 P. M.; Coal Weighed. From 2:01 to 8:10 P. M., Ind. Cards Every Hour.

Boiler pressure, pounds per square inch	207.7
I. P.¹ receiver, pounds per square inch	95.3
I. P.² receiver, pounds per square inch	38.9
L. P. receiver, pounds per square inch	7.88
Vacuum, inches	21.78
Revolutions per minute, average 6 hours	81.5
Piston speed, feet per minute	570.5
M. E. P., H. P. cyl., pounds per square inch	86.1
M. E. P., I. P.¹ cyl., pounds per square inch	29.57
M. E. P., I. P.² cyl., pounds per square inch	14.96
M. E. P., L. P. cyl., pounds per square inch	10.75
Ref. M. E. P. to L. P., pounds per square inch	34.21
I. H. P., H. P. cyl	605
I. H. P., I. P.¹ cyl	443.9
I. H. P., I. P.² cyl	468.0
I. H. P., L. P. cyl	694.9
I. H. P., total	2,211.8
I. H. P. to grate surface	13.40
Heating surface to I. H. P	3.52
Temp. of inj. water, degrees Fahr	47.1
Temp. of hot well, degrees Fahr	135.1
Temp. of feed-water, degrees Fahr	192.0
Temp. of stack, degrees Fahr	313.0
Temp. of air casing, degrees Fahr.:	
Port	234.0
Center	247.0
Starboard	231.0
Temp. of ash-pit, degrees Fahr.:	
Port	256.0
Center	262.0
Starboard	276.0
Temp. of fan intake, degrees Fahr	84.0
Temp. of engine room, degrees Fahr	88.0
Draft at fan, inches	1.57
Draft in ash pits, inches:	
Port	.40
Center	.40
Starboard	.35
Draft in air casing, inches:	
Port	.8
Center	.8
Starboard	.85
Draft in smoke-box, inches	—.26
Revolutions of fan	337
Coal, half slack, ran on grates clinkered.	
Coal, total 6 hours, 9 minutes, pounds	22,595
Coal per hour, pounds	3,674
Coal per hour per I. H. P., pounds	1.66
Coal per hour per square-foot grate, pounds	22.20
Combustible, total 6 hours, pounds	18,754
Combustible per hour, pounds	3,125
Combustible per hour per I. H. P., pounds	1.41
Ash total, pounds	3,920
Ash, percent	15
Speed of ship, miles per hour	12
From Thunder Bay Island to Detour, 73 miles	6 hours 5 minutes
Slip, percent	5.76
$\frac{I.\ H.\ P. \times 33{,}000}{P \times R}$	65,138
$C = \frac{D^{2/3} \times 5^3}{I.\ H.\ P.}$	311.5

Cuts—
H. P. 2¾ inches, I. P.¹ 1½ inches, I. P.² 1½ inches,, L. P. 1¾ inches.
Weather—Cloudy, light head wind; no sea.
Average flue-gas analysis, "CO_2" 8.4, "CO" 0, "O" 10.2.

Full Power Trial on Lake Superior, November 9

Boiler pressure, pounds per square inch	204
I. P.¹ receiver, pounds per square inch	111
I. P.² receiver, pounds per square inch	48
L. P. receiver, pounds per square inch	10.4
Vacuum, inches	21¼
Revolutions per minute	90.5
Piston speed, feet per minute	633.5
Ref. M. E. P. to L. P	39.31
Cuts	All off.
M. E. P., H. P. cyl., pounds per square inch	86.5
" I. P.¹ cyl., pounds per square inch	36.88
" I. P.² cyl., pounds per square inch	19.62
" L. P. cyl., pounds per square inch	11.81
I. H. P., H. P. cyl.	675
" I. P.¹	614.6
" I. P.²	634.8
" L. P.	847.7
" Total	2,822.1

Note.—Readings are average for one hour.

Trial Run on Lake Huron, November 8

Boiler pressure, pounds per square inch	208
I. P.¹ receiver, pounds per square inch	95
I. P.² receiver, pounds per square inch	38
L. P. receiver, pounds per square inch	8
Vacuum, inches	21.75
Revolutions per minute	81.5
Piston speed, feet per minute	570.5
Ref. M. E. P. to L. P	34.48
Cuts— H. P. 2¾ inches, I. P.¹ 1½ inches, I. P.² 1½ inches, L. P. 1¾ inches.	
M. E. P., H.P. cyl., pounds per square inch	87
" I. P.¹ cyl., pounds per square inch	30.75
" I. P.² cyl., pounds per square inch	14.87
" L. P. cyl., pounds per square inch	10.63
I. H. P., H. P. cyl.	611.4
" I. P.¹ cyl.	461.9
" I. P.² cyl.	465.3
" L. P. cyl.	687.5
" Total	2,226.1

Data for Air-Pump Cards, November 8 and 9

	Average.	Full Power.
M. E. P., pounds per square inch	3.5	4.25
Revolutions per minute	81.5	90.5
Piston speed, feet per minute	190	211
Vacuum, inches	21.5	21
I. H. P.	14.2	19.2

Henry Bell's steamboat *Comet*, which was the first passenger steamboat built in Great Britain, was launched from the shipyard of John & Charles Wood at Port Glasgow on July 24, 1812. The centenary of this historical event has therefore been fittingly observed on the corresponding date this year. The boat was laid down in October, 1811, and completed her trial trip from Greenock to Glasgow on Aug. 6, 1812. Subsequently she maintained a regular service on this and other routes until on Dec. 15, 1820, she was destroyed by the wind and tide on the rocks off Craignish Point on the west coast of Argyllshire.

A New Type of Transport Ship for Submarines

During the last few years the well-known firm of Messrs. Schneider & Co., Creusot, France, has secured a number of important orders for submarine boats for foreign navies. These boats have been built under the direction of Mr. Laubaeuf, whose design of submersible vessels is well known. It has been found somewhat difficult, however, to ship these submarines to very distant countries, as, for instance, to Peru, and, therefore, Messrs. Schneider & Co. placed an order at the Gironde Works, Bordeaux, for the construction of a peculiar type of vessel designed as a transport ship for carrying submarines on long sea voyages. This boat, which is named the *Kangaroo*, has recently been launched. Her principal dimensions are:

LAUNCH OF THE KANGAROO

Length between perpendiculars	305 feet 2 inches
Beam	39 feet 4 inches
Depth	23 feet 10 inches
Draft, loaded	19 feet 7 inches
Displacement at above draft	5,540 tons
Capacity of hold	117,000 cubic feet
Deadweight capacity	3,830 tons

The vessel is built of mild steel under a special survey by the Bureau Veritas. Her propelling machinery consists of a triple-expansion engine of 850 indicated horsepower, designed to give the ship a speed of 10 knots. The engine has been built by the Dyle & Bacalan Works, Bordeaux.

The design of the hull involves some unusual features in order to obtain a main hold 193 feet 7 inches long, extending nearly the whole width of the ship, for the accommodation of submarines. A double bottom has been worked from end to end of the ship, together with longitudinal wing ballast tanks, which are so designed as to give the ship practically the characteristics of a floating dry dock. The forward part of the ship may be connected or disconnected at will, so that the submarine can be floated directly into the main hold, inside of which it can be berthed as in a floating dry dock. When the submersible is placed in the hold, water is pumped out of the ballast tanks, causing the vessel to rise until the submarine craft is lifted out of the water, resting in a special cradle fitted inside the main hold. The forward part of the ship is then connected and the vessel becomes an ordinary cargo boat.

Owing to the arrangement of the water ballast tanks the ship may be placed at the required trim, first for the opening of the forward part of the ship, then to permit the submarine to float inside, and finally for the closing of the opening in the forward part of the ship. Aft of the main hold are the bunkers, the main and auxiliary machinery and accommodations for the officers and crew. Special accommodations are also provided for the officers and crew of the submarine, all living quarters being heated by steam and lighted by electricity.

As announced in our November, 1911, issue, James Rees & Sons Company, Pittsburg, Pa., have had under construction fourteen light-draft steamers for use on the Amazon River. Seven of these boats were shipped before May 1, and the remaining seven have just been completed, making an average of one vessel every thirty days. These steamers are 125 feet long on the deck, 26 feet beam, 3½ feet depth of hold, with engines 9 inches diameter by 4 feet stroke, furnished with steam from a locomotive type boiler. The wheel shafts for nine of these boats were made from heat-treated type A chrome Vanadium steel, by the Erie Forge Company, Erie, Pa. They are 5½ inches hexagonal and 22 feet long, with journals 5¾ inches long and 5½ inches diameter. Tests from these shafts show the following physical qualities: Elastic limit, 109,900 pounds; tensile strength, 143,400 pounds; elongation in 2 inches, 17 percent; reduction of area, 53.3 percent. A test piece, ½ inch thick by 1 inch wide, cut from the shaft, was bent over on itself cold. The electric generators for these boats were furnished by the Westinghouse Electric & Manufacturing Company, Pittsburg, the generators being directly connected to 6 by 5-inch vertical self-oiling steam engines, supplied by the American Blower Company, Detroit.

Automatic Acetylene Lights for the Panama Canal

Among the numerous interesting features connected with the Panama Canal will be found a most ingenious lighting arrangement which will make night navigation through the canal as safe as in broad daylight. At the entrances and through Gatun Lake, as shown on the accompanying map, a double row of about sixty automatic-lighted buoys will mark the channel. The contract for furnishing this lighting equipment has been awarded by the Isthmian Canal Commission to the American Gasaccumulator Company, of Philadelphia, Pa., manufacturers of the AGA automatic aids to navigation.

The buoys have been designed to meet the special requirements of the Isthmian Canal Commission, and all are equipped with AGA lanterns, having an optical range of about 12 miles. Each light will have its distinguishing characteristic, and for this purpose the lanterns will be equipped with AGA flashers, some producing single, others complex flashes. Colored lights, with their tremendous disadvantage in reducing the range of visability, will be entirely avoided.

With reference to the range lights two AGA installations have already been established at the Pacific entrance. These produce a very powerful light, having an optical range of more than 20 miles. They are equipped with flashers, but the flashes occur so rapidly that the impression of the light is continuously retained on the eye, so that the navigator can lead up to the range with the same ease as he would to fixed lights, and he has the additional security of a distinctive light character impossible of being confused with shore or ship's lights.

The AGA sun valve is also employed, which performs the functions of a keeper in extinguishing the lights at sunrise and lighting them again at the approach of darkness. The AGA sun valve is actuated entirely by light, and is not affected by temperature changes. The construction of the sun valve is based upon the well-known physical law "that absorbed light is transformed into heat." It consists of four metal rods enclosed within a stout glass cylinder. The central rod is coated with lampblack, which gives it the property of absorbing light, while the three rods surrounding it are polished and light reflecting. All of these rods expand in the same degree with the application of heat, but the inner one only responds to light, the additional expansion caused thereby being employed to actuate a valve which controls the passage of gas to the main burner. During daylight the black rod has expanded and closed the valve, at the approach of darkness it contracts and the valve opens. A continuously-burning pilot flame attached to the main burner and fed directly from the gas supply ignites the gas.

The illuminating medium of the AGA system, acetylene, is stored in large quantities in small portable steel cylinders. This is made possible by the use of what is known as "dissolved acetylene." The dissolving agent is acetone, a liquid which possesses the quality of absorbing or dissolving about twenty-five times its own volume of acetylene for each atmosphere of pressure at 60 degrees F. To prevent any possibility of explosion the cylinder, or accumulator, as it is called, is first filled with a highly porous mass of special composition, which is introduced in a pasty form and baked to hardness. The porous mass has the effect of segregating the particles of acetylene, so that an explosion wave cannot spread through the cylinder. The acetone is then forced into the accumulator until it occupies about 40 percent of the interior volume. The accumulator is then charged with pure, dry acetylene and is ready for service.

The AGA installation with four of these small accumulators of dissolved acetylene, it is claimed, will operate uninterruptedly and without attention for a year or more. The flasher, while providing a distinctive light characteristic, also effects an enormous saving of gas, due to the dark periods when gas is not being burned; ordinarily about one-tenth of

Panama Canal, Showing Location of Lights and Buoys

the gas is consumed that would be required for a continuous light. But the final word in gas economy is attained by the sun valve, which permits the gas supply to be used only during darkness, and effects, it is claimed, an additional saving of about 40 percent.

Liquid Fuel Measurement on Oil-Burning Steamships—II

BY HOWARD C. TOWLE

Having stated the manner by which the vessel's engineers can obtain accurate measurements, there still remains the other requirement for accurate results—that the measuring tank capacity be exactly obtained and recorded in such a way that this object will be obtained by simple means.

The capacity of the tank can be obtained by "water gaging" or by the ordinary methods of calculation from measured offsets. Although the first method would appear to be the most reliable, actual experience has proven that unless very carefully done, this method does not give such reliable results as careful calculation, when the possible sources of error in the latter method are avoided. There are four principal sources from which errors arise, namely, framing and other obstructions in the tank, pockets in which air may become confined, the trim of the vessel, and the list of the ship when the sounding tube is not at the center of gravity of the free surface of the liquid in the tank.

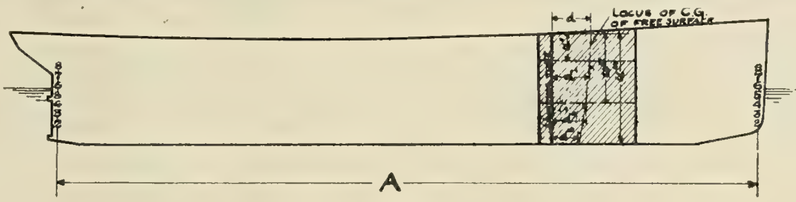


FIG. 3

Framing and other obstructions in the tank should be allowed for by direct calculation of the capacity to be deducted, and not by a percentage allowance of the total capacity, for the deduction not only varies in different tanks, but also is usually variable in percentage for the whole depth of the tank.

Confined air is only avoided by the provision of means for its ready and continuous escape from all pockets and from the highest point or points of the tank. All air-escape pipes should be fitted so as to positively exclude all water while providing means for the rapid intake or expulsion of air. Recent practice is to make the air-pipes about one-half the area of the filling pipe or the suction pipe, as the speed of the air through the pipe can safely be made considerably higher than that of the oil when the tank is being filled or pumped out.

The trim of the vessel is a constantly varying quantity, and must always be taken into consideration except in the ideal case in which the ullage can always be measured at the center of gravity of the free surface of the oil in the tank. In practice, it is seldom that it is possible or convenient to take the ullage measurements in the ideal way, and therefore it becomes necessary to obtain a method of readily correcting for trim if accurate results are to be obtained. A separate calculation of the amount of correction could be made, in the same manner as the usual correction for trim is made in calculating the displacement of vessels. The additional mathematical work is not desirable because of the increased chance of error involved, therefore the following method of making the capacity scales is suggested.

Let the shaded portion in Fig. 3 represent a tank of fuel oil located in a steamer.

Measure the distance *A* between the draft marks at the bow and the stern, or between the draft gages if they are fitted. Find the center of gravity of the free surface of the liquid at different ullages, *u'*, *u''*, *u'''*, etc., and the distances of these centers of gravity from the sounding tube, *d*, *d'*, *d''*, *d'''*. Also obtain accurately the net capacities at the various ullages, by the usual methods.

Construct a diagram as shown in Fig. 4 in the following manner: On any convenient base line, *B-B'*, erect the perpendiculars *C-F*, *D-G*, and *E-H*, so that the distance *C-D* equals *D-E*. Divide *C-F* and *D-G* into divisions corresponding to the draft of the vessel, but making the scale of *D-G* one-half the scale of *C-F*. If the sounding tube is aft of the center of gravity of the free surfaces mark the scale *C-F* "Forward" and the scale *D-G* "Aft," but if the sounding tube is forward of the centers of gravity then mark the scale *C-F* "Aft" and the scale *D-G* "Forward."

At any convenient point on the base line *B-B'* as *u* erect a perpendicular *u-u'''* and make the distance *u-u'''* equal to the total depth of the tank on any suitable scale that bears a definite ratio to the draft scale *C-F*, and divide the distance to read ullages from the line at *u* to the point *u'''*.

Take points on the scale *u-u'''* as *u'*, *u''*, *u'''*, so that the distances *uu'*, *uu''*, *uu'''*, are equal to the ullages *u'*, *u''*, *u'''*, in Fig. 3 to scale, and draw lines from these points to the point *E*.

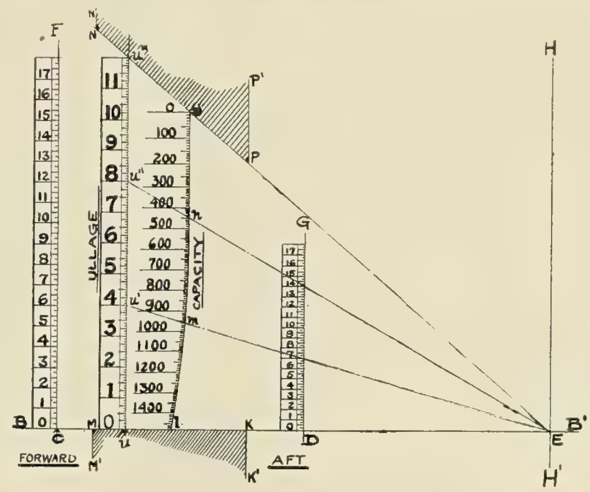


FIG. 4

Divide the distances *Eu*, *Eu'*, *Eu''*, *Eu'''*, at *m*, *n*, *o*, so that the distances

$$\frac{mu'}{mE} = \frac{d' \times \text{scale of } u\text{-}u'''}{A \times \text{scale of } C\text{-}F}$$

and

$$\frac{nu''}{nE} = \frac{d'' \times \text{scale of } u\text{-}u'''}{A \times \text{scale of } C\text{-}F}$$

and

$$\frac{ou'''}{oE} = \frac{d''' \times \text{scale of } I\text{-}J}{A \times \text{scale of } C\text{-}F}$$

and

$$\frac{lu}{lE} = \frac{d \times \text{scale of } u\text{-}u'''}{A \times \text{scale of } C\text{-}F}.$$

Draw a curve, *l, m, n, o,* through the spots so obtained, mark the capacity at each ullage depth along *l, m, n, o,* and subdivide for the intermediate capacities. The spot for zero capacity is evidently on a line from *E* to the total depth spot u''', and the spot for the total capacity is at *u* on the base line *B-B'*.

The method of using the scale is as follows: After the draft forward and aft, and the ullage are measured, the drafts forward and aft are laid off on their respective scales, *C-F* and *D-G* and a straight-edge laid across the two points. The point of intersection of the straight-edge and the line *H-H'* is marked. Then the straight-edge is shifted so that it goes through the spot on *H-H'* just obtained and also through the point on u-u''' corresponding to the measured ullage of the liquid in the tank. The capacity indicated by the intersection of the straight-edge on the line *l, m, n, o,* is the capacity corrected for trim, provided that the level of the liquid in the

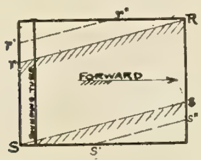


FIG. 5

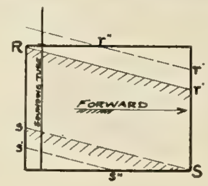


FIG. 6

tank is not above the upper corner of the tank (*R* in Figs. 5 or 6) or is not below the lower corner of the tank (*S* in Figs. 5 or 6).

In practice no engineer would work so little margin of fuel as the lower level represented, and the tank should never be completely filled, in order to allow room for possible expansion due to changes in temperature, so for all practical purposes the diagram without the limiting areas shown in Fig. 4 will be sufficient. If desired, however, a limiting ullage for any trim can be obtained as follows: In Fig. 4, divide the distance *u-E* at the point *K* so that

$$\frac{u\text{-}K}{K\text{-}E} = \frac{\dfrac{\text{Distance from the tube to upper forward end}}{\text{Length between draft marks } (A)} \text{ of the tank} \times \text{scale of } u\text{-}u'''}{\times \text{ the scale of } C\text{-}F}$$

erect a perpendicular at the point *K* as *K-K'* and shade the area *u-K-K'*, the shaded portion represents the incorrect zone at the top of the tank when the vessel is by the head. Also make

$$\frac{u\text{-}M}{u\text{-}E} = \frac{\dfrac{\text{Distance from tube to upper after end}}{\text{Length between draft marks } (A)} \text{ of tank} \times \text{scale of } u\text{-}u'''}{\times \text{ scale of } C\text{-}F}$$

Erect the perpendicular *M-M'* and shade the area *u-M-M'*. Then the shaded area represents the incorrect zone at the top of the tank when the vessel is by the stern. Divide the line u'''-*E* at the points *P* and *N* in the same ratio, but using the distances from the sounding tube at the bottom of the tank. Draw *P-P'* and *N-N'* perpendicular to the base, and shade the area *N N' PP'*, the shaded area representing the incorrect zone at the bottom of the tank.

Now, in using the straight-edge for reading capacities, when the edge is laid across the diagram from the ullage point on u-u''' to the trim spot on *H-H'*, if it is found that the straight-edge bisects the shaded portion of the figure, it will be known that the liquid in the tank comes above the upper corner of the tank or below the lower corner, as the case may be (*R* or *S* in Figs. 5 or 6), and that the correct capacity cannot be obtained directly from the diagram. The capacity should then be taken for the ullage intersected when the straight-edge intersects the trim spot on *H-H'* and either of the points *P, K, M,* or *N* and the additional volume *R, r, r', r''*, or volume to be subtracted *S, s, s', s''* (see Figs. 5 and 6) be separately calculated. This can be done for all conditions of trim except when the trim throws the oil in the bottom of the tank entirely clear of the sounding tube, as *S'-s''* in Fig. 5, which case can only be taken care of by additional piping.

For a rectangular tank the added or subtracted capacity can be obtained by the formula:

$$\text{Volume} = X\,(B \times L) - \frac{X^2}{T}\left[\frac{A \times B}{2}\right]$$

Where:

A = The length between the draft marks or gages of the ship;
B = The breadth of the tank;
L = The length of the tank;
T = The trim of the ship;
X = The difference between the measured ullage and the ullage indicated by the straight-edge passing through the trim spot on *H-H'* and the points *K, M* or *P*.

The expressions within the parentheses are constant for any given case and the trim of the vessel and the ullage are the only variables.

It will be noted that to take such a case as is represented by *R, r, r', r''*, in Fig. 6, it would be necessary for the sounding pipe to extend above the top of the tank, and for the ullage scale, *I-J*, to be laid off from the top of the sounding tube, or if laid off from the top of the tank, the distance *X* in the formula, should be made equal to the distance from the ullage intersected on Fig. 4 by the straight-edge to the top of the tank, plus the negative ullage above the top of the tank.

The derivation of this method of measuring capacities can be shown by taking as an example a rectangular tank located

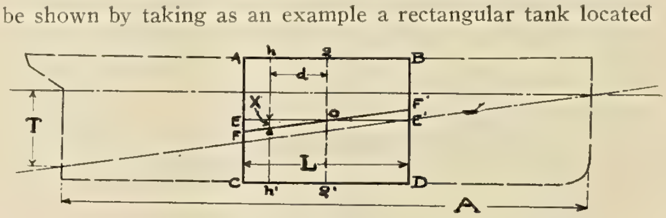


FIG. 7

in a vessel as *A, B, C, D,* in Fig. 7. Let *E-E'* be the surface of the liquid in the tank when the vessel is on an even keel, and *F-F'* the surface when the vessel has been given trim as represented by the distance *T*. (It is evidently immaterial whether the draft changes or not.)

As the surface of the liquid in the tank always remains parallel to the surface of the sea at any trim, it is evident that any change in the ullage, as *X*, shown in the sounding tube *h-h'*, due to a change in the trim of the vessel, will be proportional to the distance *d* and the length between draft marks *A*; or:

$$\frac{\text{Change in ullage “}X\text{”}}{\text{Change in trim “}T\text{”}} = \frac{d}{A}$$

In a trapezoid the triangles adjacent to the parallel sides are similar, for all corresponding sides are parallel, and, therefore, the corresponding sides are proportional to the bases of the triangles. Thus in Fig. 8 in the trapezoid *K, L, M, N,*

$$\frac{P\text{-}K}{P\text{-}M} = \frac{K\text{-}N}{L\text{-}M}$$

Let Fig. 9 be a capacity diagram laid out in the same manner as that shown in Fig. 4, except that the scale for ullages and

for draft (C'-F') are the same. Let C'-F'' and D'-G'' be the drafts forward and aft, draw the straight line F''-G''-E' and note the intersection M on the capacity line L-O. Now, let the vessel trim the amount T', and draw the line, E''-M-F', intersecting the ullage line U-U''' at the point U''. Now it is evident that

$$\frac{X'}{T'} = \frac{U'\text{-}M}{M\text{-}E'}.$$

as demonstrated by Fig. 8.

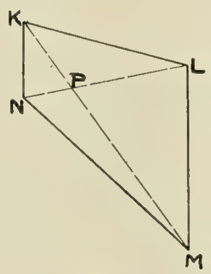


FIG. 8

But when we constructed the diagram we located the capacity line L-O by the proportion,

$$\frac{M\text{-}U'}{M\text{-}E'} = \frac{d}{A}$$

(the scales being the same, the ratio of the scales becomes equal to unity) and, therefore, by combination we have

$$\frac{X'}{T'} = \frac{d}{A},$$

and a line drawn from E'' to the point U'' will give the required reading on the capacity scale L-O for the same capacity with any change in trim.

It will be noted that it is assumed that the ullage-rod is constrained by a tube, or other means, to move parallel to the draft marks at the bow and stern of the vessel. For moderate trim and small ullages the error due to the ullage rod hanging free would be immaterial, but when considerable change in trim is probable between successive measurements, as in vessels with their machinery aft, a tube should be fitted for accurate results.

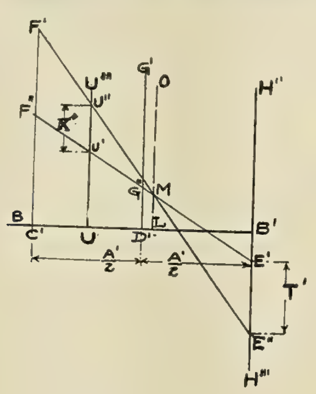


FIG. 9

Any change in the trim of the vessel evidently does not change the volume of the liquid in any tank in the vessel, and, therefore, in Fig. 7 the triangles, $E\ O\ F$ and $E'\ O\ F'$, must be of equal area. But in a rectangular tank the triangles can only be equal when the point O is at the half-length of the tank; in other words, the center of gravity of the free surface of the liquid. If the sounding pipe was located so as to go through these points for the whole depth of the tank, it is evident that no change in ullage would result from any change in trim.

Errors due to the list of the ship can be correctly allowed for by a similar method to that used for correcting for the trim of the ship. In Fig. 10, let $A'\ B'\ C'\ D'$ represent the transverse section of the tank, which may or may not be symmetrical about its center line. Let g-g' be the calculated locus of the center of gravity of the free surface, h-h' the location of the sounding tube, and let d' be the distance of the tube from the locus, and E-E' any level of the liquid in the tank.

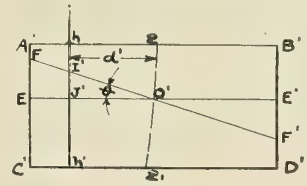


FIG. 10

Let F-F' be the surface of the liquid when the inclination of the vessel is θ degrees, as shown by the vessel's clinometer.

Then it is evident that I'-J' is to $(EF + E'\ F')$ as $O'\ J'$ is to E-E'.

But I'-J' is the change in ullage reading due to the inclination θ, and $(EF + E'\ F')$ is equal to $EE' \times \tan\theta$; therefore (introducing the ratio of the scales used in drawing the diagram, Fig. 11), we obtain the proportion,

$$\frac{\text{Change in ullage}}{\text{Tan } \theta \times \text{breadth of tank}} = \frac{d' \times \text{scale of ullage } (U\text{-}U' \text{ in Fig. 11}).}{\text{Breadth of tank} \times \text{scale of } (N\text{-}N' \text{ in Fig. 11}).}$$

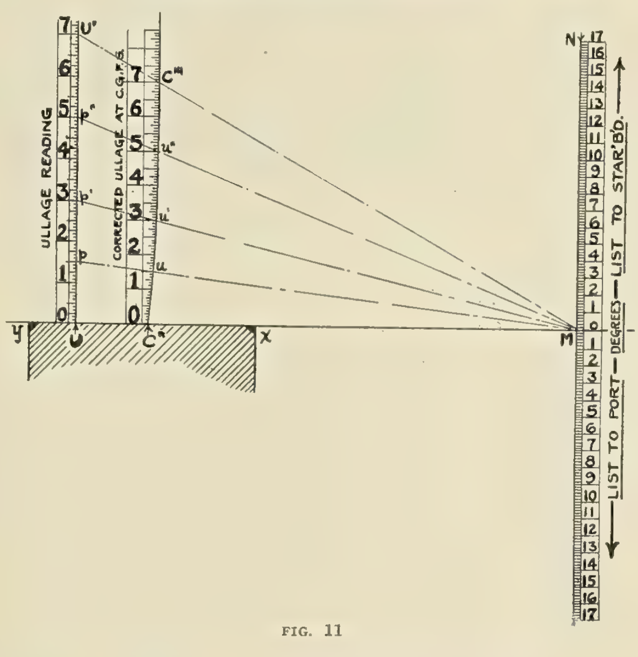


FIG. 11

Using the property of the trapezoid referred to above, construct the diagram shown in Fig. 11 in the following manner:

On the base line U-M erect the perpendiculars U-U' and N-M-N'; divide the line U-U' into equal parts to any definite scale to represent the ullages as read on the vessel, from zero to the full depth of the tank. Lay off on N-M-N' distances above and below the point M, making the distance for each degree of heel equal to tan $\theta \times$ the mean breadth of the tank, to any definite scale. From points on the ullage scale, U-U' as p, p' p'', corresponding to the ullages at which the distances d' in Fig. 10 were calculated, draw lines to the point M as

p-M, p'-M, p''-M, U'-M. Divide these lines at u, u', u'', C''', in the proportion,

$$\frac{p\text{-}u}{u\text{-}M} = \frac{d' \times \text{scale of ullage } (U\text{-}U')}{\text{Breadth of tank} \times \text{scale of } \tan\theta \times \text{breadth of tank } (M\text{-}N)}$$

Draw a curve, C'', u, u', u'', C''', through the spots obtained, and subdivide so that a straight-edge passing through the spot M will intersect the same figure for ullage on both the scales, U-U' and C''-C'''.

If the sounding tube is toward the port side from the center of gravity of the free surface of the liquid in the tank, mark the scale M-N "List to port," and the scale M-N' "List to starboard," but if the sounding tube is toward the starboard side from the center of the surface, mark N-M "List to starboard" and M-N' "List to port."

In using the diagram spot off on N-M-N' the list of the ship in the proper direction, and spot off on U-U' the ullage as read from the tank. Lay a straight-edge across the diagram through the two spots and obtain from the scale C''-C'''; the equivalent ullage at the center of the free surface of the liquid in the tank. Use this latter figure for ullage instead of the ullage read from the tank in finding the capacity from the diagram shown in Fig. 4.

Incorrect zones at the top and at the bottom of the tank can be established in a similar manner to those for trim of the vessel by using the proportions following and referring to Figs. 10 and 11.

$$\frac{U\text{-}x}{x\text{-}M} = \frac{h\text{-}B' \times \text{scale of } U\text{-}U' \text{ (scale of ullage)}}{\text{Breadth of tank} \times \text{scale of } M\text{-}N' \ (\tan\theta \times \text{breadth})}$$

$$\frac{U\text{-}y}{U\text{-}M} = \frac{h\text{-}A' \times \text{scale of } U\text{-}U' \text{ (scale of ullage)}}{\text{Breadth of tank} \times \text{scale of } M\text{-}N' (\tan\theta \times \text{breadth})}$$

To find the equivalent ullage in the incorrect zones, find from the diagram the corrected ullage and also the sounding tube ullage (u) when the straight-edge intersects the corner of the incorrect zone. Subtract from the latter the ullage taken from the tank and call the difference "X." Also let

u = the ullage measured from the sounding diagram by the straight-edge, viz.: the tube ullage;

B = the breadth of the tank (mean breadth);

D = the distance from the sounding tube to the port side of the tank;

D' = the distance from the sounding tube to the starboard side of the tank.

Then when the list is to starboard, the decrease from the corrected ullage when the straight-edge intersects the corner of the incorrect zone at the top of the tank, or the decrease at the bottom of the tank, equals

$$X - \frac{X^2}{u} \left[\frac{D'}{2B}.\right]$$

When the list is to port, the decrease at the top of the tank, or the increase at the bottom of the tank, equals

$$X - \frac{X^2}{u} \left[\frac{D}{2B}.\right]$$

The expressions within the parentheses are constants for any given tank. Use the net corrected ullage for obtaining the capacity contained in the tank from the diagram shown in Fig. 4 as before.

These methods of determining the amount of liquid contained in a tank are absolutely accurate for rectangular tanks, but in tanks of rapidly changing form there is an error due to the fact that the center of gravity of the free surface of the liquid varies in distance from the sounding tube with changes in the list and the trim, but in practice it will be found that the average tank approximates to the rectangular form, so that the error from this source usually amounts to but a small fraction of 1 percent, and can be neglected.

The error due to the slight changes in the capillary effect between the measuring rod and the liquid in the tank, for different conditions of temperature and surfaces, may also be neglected in practice.

The Steamship New Londoner

Last spring Messrs. Irvine's Shipbuilding & Dry Docks Company, Ltd., launched from their harbor dockyard the handsome steel screw passenger and cargo steamer *New Londoner,* built for Messrs. The Tyne-Tees Steam Shipping Company, Ltd., Newcastle-on-Tyne. The vessel is designed as an intermediate steamer, suitable for their various trades. Her dimensions are as follows: Length, 275 feet by 35 feet by 16 feet 6 inches depth molded, having a long, full poop and forecastle, with a bridge 82 feet long over the poop; the poop, bridge and forecastle decks are sheathed with wood, and a steel lower deck is fitted in No. 2 hold.

The vessel is built to the highest class under the British Corporation classification, having cellular double bottom for water ballast all fore and aft, also in the fore and after peaks. She is divided into six compartments by five transverse bulkheads. Accommodation for the first class passengers is arranged in the bridge, and comprises large and well-ventilated and lighted staterooms having two berths each. The dining saloon is tastefully decorated with a dado of Chippendale mahogany, the upper panels being white and gold. Accommodation for a limited number of second class passengers is fitted in the after end of the poop. The officers and engineers' accommodation is situated in the bridge.

A promenade deck is formed amidships about 80 feet in length for the passengers, and four lifeboats are placed on this deck, giving ample boat accommodation for all the passengers and crew; a small working boat is also fitted aft. At the fore end is a large entrance hall and a spacious room for the captain, chart and wheelhouse, with a flying bridge overhead. The crew, firemen and petty officers are housed under the forecastle, where are also the lamp room, paint, stores, etc.

Particular attention has been paid to the appliances for loading and discharging the vessel, there being six powerful steam cranes and self-slewing steam winches, a 12-ton derrick being fitted at No. 1 hatch.

A complete installation of electric light is fitted throughout, including signal lamps, binnacles and clusters for each hatch, also electric bells for the first class passengers, as well as a complete outfit of oil lamps as a stand-by. A steam steering gear on the Wilson & Pirrie principle is placed in a house aft and coupled up direct to the rudder stock, with powerful screw gear in case of emergency, and a quick-warping windlass is fitted on the forecastle for hoisting the anchors.

The engines, which are of the triple-expansion type, were fitted by Messrs. Richardsons Westgarth & Company, Ltd., Hartlepool, the cylinders being 22½ inches, 37 inches and 61 inches diameter by 42 inches stroke. Steam is supplied by two large single-ended boilers working under forced draft at a pressure of 180 pounds per square inch. The design of machinery embodies the engine builders' latest practice, the main condenser being of the "Contraflo" type, with temperature regulator. The feed pumps are of the slow-speed

independent type, and work in connection with a Cascade filter tank and surface feed heater. Extra large ballast and auxiliary duplex feed pumps are provided, and other accessories in the engine room include an Aspinall's governor and mechanical lubricators of the "Octopus" type. The machinery has been constructed to the specifications of Mr. D. Belford, Newcastle, under whose supervision the contract has been carried out.

The vessel carried out progressive trials over the Whitley Bay meausred nautical mile, and ran from 9 knots up to 14½, which is her maximum speed when fully loaded. This was considered highly satisfactory, as the guaranteed speed was only 13 knots.

Molasses Tank Steamer Nelson

The steamship *Nelson*, building by the Fore River Shipbuilding Company, of Quincy, Mass., for the Cuba Distilling Company, of Habana, Cuba, was launched Aug. 12. The *Nelson* is an improved duplicate of the steamer *Currier*, built by the Fore River Shipbuilding Company and owned by the Cuba Distilling Company, and will be engaged in the transportation of molasses in bulk between Cuba, Porto Rico and American ports, principally New York. She is also constructed in such a way as to enable her to enter the transatlantic trade. The principal dimensions are as follows:

Length between perpendiculars	370 feet.
Beam, molded	52 feet.
Depth, molded to upper deck	30 feet.
Draft, loaded	23 feet.
Gross tonnage (about)	4,700 tons.
Net tonnage (about)	2,800 tons.

The vessel can be used for the transportation in bulk of molasses, oil or other liquid cargo. The total stowing capacity for molasses is 190,000 cubic feet, representing over 1,400,000 gallons. When carrying petroleum, with the oil carriage and tanks and inner bottom, the vessel will have a capacity of 1,600,000 gallons.

The vessel has three pole masts, fitted with cargo booms having a capacity of 5 tons each. The propelling machinery is located in the stern of the ship, consisting of a vertical inverted, three-cylinder, triple-expansion engine, with cylinders 25 inches by 41 inches by 68 inches, and a common stroke of 48 inches, supplied with steam at 190 pounds pressure by three single-ended Scotch boilers, working under the heated forced draft system. The engine will develop a maximum of 2,700 horsepower, which will give the vessel a speed of more than 12 knots.

For a complete description of this vessel the reader is referred to the article published on page 20 of the January, 1911, issue of INTERNATIONAL MARINE ENGINEERING, where full details, including drawings of the hull and machinery of the duplicate ship *Currier*, are given. The principal differences in the two ships lie in the general arrangement of the hull. The *Currier* has five double tanks bounded by transverse and centerline bulkheads, with a general cargo hold forward and aft of the tanks, whereas the *Nelson* has seven double tanks with no general cargo holds. The total capacity for stowing molasses is therefore greater in the newer ship, being in this case 190,000 cubic feet, representing 1,400,000 gallons of molasses, as against 138,000 cubic feet, representing 1,000,000 gallons in the *Currier*.

The propelling machinery is practically identical in both ships except for a few minor changes. The *Nelson*, however, has two 15-kilowatt, direct-connected General Electric marine generating sets, whereas the *Currier* had only one of this size. The auxiliary condenser is also larger in the *Nelson*, having 4,000 square feet of cooling surface, that on the *Currier* having only 1,002 square feet of cooling surface. This change necessitated using an auxiliary condenser circulating pump 7½ inches by 8½ inches by 10 inches on the *Nelson* in place of one 6 inches by 4 inches by 6 inches on the *Currier*. Otherwise practically the same auxiliary machinery was installed in both vessels.

LAUNCH OF THE NELSON AT THE FORE RIVER SHIPYARD

The Speediest Destroyer of the French Navy

What is said to be the fastest destroyer in the French navy is the *Bouclier*, recently built by Messrs. A. Normand & Co., Havre. On her recent official trials she maintained a speed of 35.334 knots, whereas the contract called for only 31 knots. The vessel is driven by the latest improved Parsons turbines, built by the Compagnie Electro-Mancanique, of Le Bourget, near Paris. She has the following particulars:

Length over all	233 feet 4 inches
Beam	24 feet 10 inches
Depth	16 feet 5 inches
Draft	12 feet 6 inches
Displacement, full load	660.4 tons
Contract speed	31 knots

Her hull is built with a flush deck fore and aft, except for the forecastle deck, which gives a high freeboard forward. The hull is divided into ten watertight compartments. The crew is berthed forward and the officers and petty officers aft.

The armament consists of two 4-inch, quick-firing guns, one forward and one aft; four 2.5-inch, quick-firing guns, two on each side; four 18-inch torpedo tubes; the ammunition supply includes 450 rounds per gun and 6 torpedoes.

Steam for the turbines is supplied by four oil-fired Normand watertube boilers, located in two watertight compartments. Each of them is fitted with nine Normand burners, receiving the fuel from Normand special heaters. The heating surface of each boiler is 5,277 square feet, the working pressure being 228 pounds per square inch. At full power the boilers are operated under a pressure of 4.4 inches of water.

The main engines consist of three sets of turbines, each driving a separate shaft. A high-pressure turbine drives the center shaft, and two low-pressure turbines drive the wing shafts. They have been designed to work at 1,000 revolutions per minute, the propellers being 5 feet 3 inches diameter and 4 feet 11 inches pitch.

The results obtained on the full-power trial were as follows:

Duration of trial, hours	6
Trial displacement, tons	660.44
Pressure at boiler, pounds	217
Pressure at steam chest, pounds	183
Pressure of fuel at burners, pounds	143
Revolutions, average	1,034.02
Speed, average knots	35.334
Speed, contracted, knots	31
Shaft-horsepower	15,000
Vacuum, inches	28
Fuel consumption per hour, pounds	21,192
Fuel consumption per contract, pounds	29,781
Fuel consumption per shaft-horsepower, pounds	1.46
Eight-hour consumption trial:	
Revolutions per minute, average	325.18
Speed, average knots	14.06
Brake-horsepower	1,400
Vacuum, inches	28.1
Consumption per hour, pounds	1,915
Consumption per shaft-horsepower, pounds.	1.36

A Diesel Motor Tank Vessel

BY DR. ALFRED GRADENWITZ

The German-American Petroleum Company, which already commands twenty-three steamers, aggregating more than 84,000 gross tons, has entrusted several firms of German shipbuilders with the construction of some further vessels intended for the transport of petroleum between Europe on one side and North America or the Far East on the other, thus increasing and partly renovating its present fleet. Part of these new vessels—all of which are being designed as tank vessels—will be propelled by motors, thus embodying for the first time in this special branch of shipbuilding an undoubted advance, which, quite apart from other reasons, would seem to deserve early imitation because of the reduced fire risk.

Among the motor vessels ordered in this connection, a tank vessel of about 15,000 tons carrying capacity seems to be of more than passing interest, because of its extraordinary dimensions. Apart from being the largest motor ship so far in existence it will, in fact, be the largest tank vessel so far constructed.

This vessel is being built by Messrs. Krupp Germaniawerft, of Kiel, according to the new Isherwood longitudinal frame system, as a shelter-deck vessel carrying three continuous decks. Its dimensions will be as follows:

Length	528 feet.
Breadth	66.63 feet.
Height at sides	41.48 feet.

As owing to special arrangements nearly the whole upper 'tween deck is left out of account, the net tonnage is relatively small as compared with the dimensions of the vessel.

The tanks occupy about two-thirds of the length of the vessel, being divided by transverse bulkheads into eleven compartments, each of which is in turn sub-divided into two separate tanks by a continuous longitudinal central bulkhead. These tanks are continued as far as the third deck, whence an expansion shaft extending the whole length of the tanks goes to the second deck, taking up one-quarter of the whole breadth, and thus reducing the freely-moving surface of the liquid cargo to one-quarter of the breadth of the vessel. Beside the walls of this expansion shaft there are arranged some "summer" tanks, intended on one hand to afford additional carrying capacity for an oil load of lower specific weight than the average petroleum, and on the other to allow existing regulations in regard to the load-line to be more easily complied with in the different seasons of the year. In order to protect the terminal compartments against any invasion of oil in case of leakage of the tanks, cofferdams, consisting of a shelter formed by two bulkheads, are fitted into their forward and after ends. Another cofferdam inserted between the tanks No. 2 and No. 3 allows different kinds of oil to be safely separated from one another.

Between tanks No. 5 and No. 6 there is provided a pump room containing steam pumps of 15.2 inches and 12.4 inches cylinder diameter, respectively, and 18.4 inches stroke, which are able in a short time to empty the holds. Arrangements have also been provided for allowing these pumps to be used as suction pumps, drawing in the oil from the shore. The suction and pressure pipes are so arranged as to allow the pumps to draw in the oil from any tank, transferring it into any tank desired.

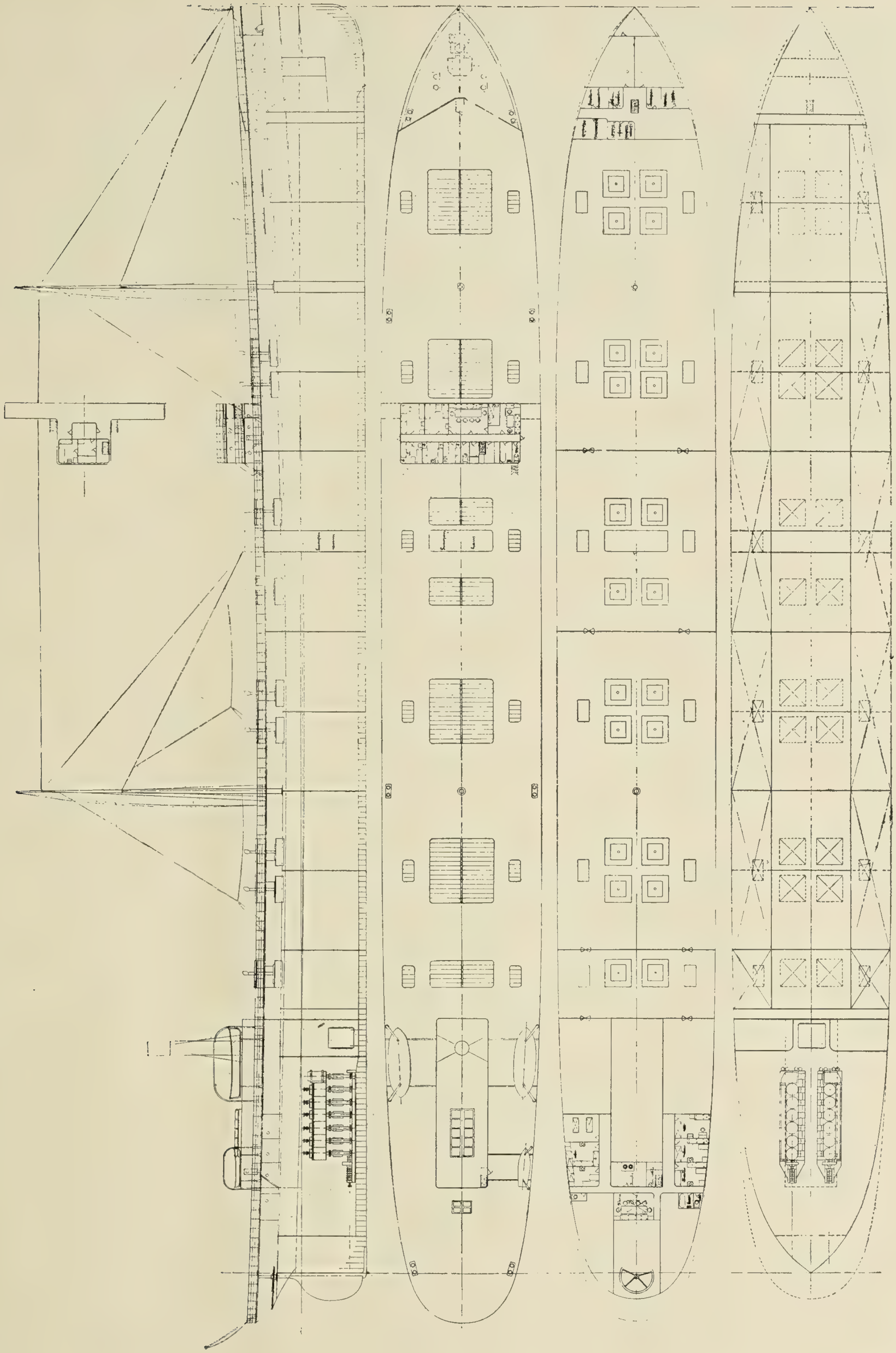
In order to allow the holds to be entered without any risk for the sake of inspection or repair work, any residual poisonous gases should be removed, allowing fresh air to take their place. To effect this the suction pipes of the holds can be connected to a powerful steam-driven fan drawing off in a short time any poisonous gases and throwing in fresh air into the tank. This ventilation is activated considerably by blowing steam into the holds. Moreover, all the holds are well ventilated, the discharge tubes being carried up the masts.

Two single-action, two-cycle Diesel motors, designed according to the Germania Shipyard's special system, are used to propel the vessel. These two motors, with about 125 revolutions per minute, yield a total output of about 3,500 effective horsepower, imparting to the vessel an ocean speed of 10 knots.

The electric light and power plant comprises two 110-volt dynamos, direct coupled to engines of 35 horsepower each. Electric drive is provided for a fire pump, a deck rinsing pump, a ballast pump and an oil pump destined to replenish the fuel tank. Some further pumps in the engine room for the transfer of ballast or fuel are operated either by steam or by compressed aid generated by the motors. In a similar manner the rudder machine, while being generally driven by compressed air, is provided with steam connections.

The steam required for heating as well as for operating the two oil pumps, the oil transfer pump, ballast pump and the dynamo is generated in a small auxiliary boiler designed for oil fuel.

The new vessel has been assigned the highest class of the British Lloyds ✠ 100 A-1, and is being fitted up with the most up-to-date arrangements, corresponding to the latest advances in engineering.



LONGITUDINALLY FRAMED DIESEL ENGINED TANK VESSEL OF 15,000 TONS CARRYING CAPACITY

Plans for a New Steamship Terminal in New York Harbor

BY H. McL. HARDING*

On account of the congestion along the waterfront of the Island of Manhattan there are now some thirty-three companies unable to obtain berthing facilities, and it is necessary that other locations at the port of New York be found where large terminals can be advantageously situated.

It is essential that at a place to be selected for such a terminal it should be possible to successfully fulfill all the requirements of a modern terminal, so as to secure rapidity and economy of transference, and that it should be in every respect a transhipment terminal. It should not be chiefly a railway terminal with classification yards, transfer and distributing yards predominating, but a combination of all that make up a correctly planned terminal, with all the elements properly proportioned. Not only must provision be made for the foreign and coastwise commerce, but also for the transcontinental and intercoastal commerce.

In addition, there are the fast-freight export shipments, now becoming so important, which give emphasis to the necessity for the rapid handling of freight at any terminal.

As discussed at the last International Congress of Navigation, held in Philadelphia in May and June of this year, it was recognized that a terminal consisted of a number of important elements, none of which could be dispensed with if the terminal was to be able to compete successfully with other cities for the ever-increasing foreign and domestic trade. A terminal must have all its elements co-ordinated or tied together; that is, the warehouses, industrial sections, railroad tracks, the outbound and inbound houses, each with their respective tracks and platforms, the transfer station, classification yards, car storage yards with ample placement tracks supplementing the transfer station; then the sheds rearward of the piers, the piers, wharves, and the latest type of transit sheds, and all of these connected by such standard mechanical transferring appliances as have proved most successful.

Location

As the through or commercial traffic, inland, even to the Middle West, including the domestic as well as the foreign, comprises a large proportion of the total freight handled in New York harbor, a terminal to provide for this must be so arranged that the freight can be transferred, as far as the character of the freight will permit, directly between the vessel and the car, thereby avoiding the expense of rehandling by manual labor, of lighterage, which costs 60 cents (2/6) or more per ton, and of high land rental or interest, which must be charged to every ton. The reduction in the expense for manual labor alone for this transference will be about 20 cents (0/10) per ton. There is also a possible saving, due to the rapidity of transference, in the charter value of steamships estimated at 12 cents (0/6) per ton. If all the possible economies can be effected there will be a positive saving of 60 cents (2/6) lighterage, plus 18 cents (0/9) pier rental, plus 20 cents (0/10) mechanical transferring, plus 12 cents (0/6) charter value saving in time, making a total saving of $1.10 (4/7) per ton.

To eliminate the lighterage charges for this through or commercial freight, the terminal can be located most advantageously on the mainland of New Jersey, but not in such places as would require bridges or long trestles near the terminals to connect with the West, and not on wholly or partially submerged Government or State lands. There must also be the possibility of connecting with two or more competing railways.

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At first it seemed impossible to satisfy all these conditions, but finally, after much difficulty, between 900 and 1,000 acres were purchased on the mainland of New Jersey at the junction of the Staten Island Sound and the Rahway River, and plans have been prepared for the erection there of a modern steamship terminal to be known as the Montgomery Terminal. The site is about midway between the Raritan Bay and the Kill von Kull and to the west of Staten Island, thereby securing a protected waterway either to the North or to the South.

The width of Staten Island Sound opposite the Montgomery Terminal is about the same as the Thames at London, and by dredging the point of an island now controlled by the terminal a width of nearly half a mile can be secured. Below the terminal the Sound gradually widens.

Through this Sound there passes a traffic of nearly 30,000,000 tons annually. There is a depth of 21½ feet at low water and above 26 feet at high water.

Capacity of Terminal

As planned there will finally be a track capacity pertaining to the terminal of not less than 30 miles and a car placement of some 3,000 cars. This trackage will include the distributing leads, storage tracks and sidings.

The transferring capacity per lineal frontage of quay or pier wall, as planned, provides for not less than 4,000,000 tons annually. This is based upon the experience of many ports, even those not equipped with modern appliances. The estimate is most conservative.

Within the slips and along the quay walls of the Staten Island Sound section the plans provide for berthing facilities for twelve large-sized freighters at the same time, and further development will add eleven more, besides space for a number of barges and lighters.

Upon the north side of the Rahway River, and along the quay walls of the basin, there will be berthing facilities for thirteen additional large freighters, besides room for barges and lighters. Upon the south side of the river there will be berthing frontage for thirteen additional steamships.

It is to be noted that the river and basin constitute an enclosed tidal dock similar to those of foreign ports.

Instead of giving the number of square feet of the floor area of the sheds or other buildings as a capacity unit, which are generally considered as tiering the goods only 5 feet in height, it is more correct to give the available or effective cubical contents in terms of tonnage-holding capacity. Allowing 100 cubic feet per ton instead of 40 cubic feet per marine ton, and which is nearer correct for miscellaneous freight, and tiering 20 feet in height, due allowance being made for passageways, then the holding capacity of the five pier sheds, as shown, each one story in height, would be a total of 61,200 tons. The sheds are of such height that the miscellaneous freight can be tiered 10 feet higher, proper consideration being given to the character of the freight.

As shown, there are twenty-seven land sheds, each 400 feet by 100 feet, and of one and one-half stories in height. Using the upper story for holding, or in some cases for storage, supplemented by the temporary holding capacity of the first half-story, there would be a total holding capacity in the twenty-seven sheds of 183,600 tons.

Six warehouses are provided, each 100 feet by 300 feet, and these will have a total storage capacity of 72,000 tons. These warehouses are so arranged that they can be extended 300

feet further towards the north, thereby doubling the storage capacity.

RAILWAY CONNECTIONS

This terminal is so located as to have direct railway connection with two lines of the Central Railroad of New Jersey, the main line of the Pennsylvania Railroad, and either directly or through other lines with the Lehigh Valley, the Baltimore & Ohio, the Philadelphia & Reading, the Erie, the West Shore, and by water with the New York Central and the New York, New Haven & Hartford.

SHEDS

The sheds about the slips will be constructed of steel frames with corrugated walls with reinforced concrete foundations. The sheds directly back of the piers on the Sound section and to the east of the basin constitute what may be called warehouse sheds. There have been planned seven groups, each of four buildings, making twenty-eight in all, to be built as needed and divided by fire walls. They will be one and one-half stories in height of steel frame on reinforced concrete foundation. The walls will be of reinforced concrete and the roofs of cement tile.

The warehouses proper will be of similar but heavier construction, with walls of reinforced concrete and of several stories in height.

In the beginning there will be two groups of these warehouses, each composed of three buildings. The large cotton sheds will finally be located south of the river, and will be of reinforced concrete, divided into sections by concrete partitions, each partition to hold the limited number of bales as required by the underwriters.

According to the latest methods at other terminals the roofs of these sheds will consist of movable roof panels, so constructed as to form rolling hatches, which can be moved to one side, so that the whole or part of a roof can be opened, and through these roof hatches loads can be raised or lowered by modern machinery, and by one operation transported to or from a ship's hold.

These details, as to the type of building and the handling of cotton and other commodities, have been carefully worked out for each class of freight. A distinction will be made between the type and location of warehouses for long storage; that is, for a number of months, and for what may be called "transit freight warehouses" in distinction from the transhipment sheds. As soon as the volume of business requires it, it is planned to locate the long-storage warehouses in the industrial section.

According to the "Report on Terminals," by the Hon. Herbert Knox Smith, formerly Commissioner of Corporations of the United States, one of the essential elements of a terminal is the industrial section. This space, as shown, has been laid out for industrial lofts, and for the larger as well as for the smaller industrial establishments.

To the rear of this section, to the west, is a large area for additional trackage, other industrial establishments and the residential section. This has been designated as the industrial area, a distinction from the industrial section.

PLAN FOR MONTGOMERY TERMINAL ON NEW JERSEY MAINLAND, STATEN ISLAND SOUND, PORT OF NEW YORK

TRANSFERRING MECHANISM

In order to determine what classes of machinery should be installed, so as to secure the greatest rapidity and the least cost of transference, the different kinds of commodities to be handled should be separately considered.

For mechanical transhipment freight can be divided into two great classes; the first being bulk freight, such as ore, coal, phosphate and sulphur, and the second, miscellaneous cargoes of steamships and the package freight of cars, consisting of boxes, barrels, cases, packages of every kind, size, weight and description, from a grand piano or a hogshead of tobacco, to a crate of eggs or a case of feather-weight millinery.

In addition, there are cargoes of one commodity, but often of many marks, such as cotton, sugar, coffee, rice and bales of many kinds of material. These would be handled by the same class of machinery as package freight. There is, moreover, a third class, consisting of exceptionally heavy or bulky units which cannot well be divided, for which a few special machines are adapted.

The movement of bulk material is generally between two points only, and the chief requirement is continuous rapidity. This is attained by means of grab buckets of various types in combination with link belt conveyors or various forms of rubber belt conveyors, moving platforms or chains.

Locomotive cranes can often be advantageously employed, but at terminals where there is a large proportion of waterfront to the terminal area, a floating crane is of the greatest utility. It can be easily moved from one place to another, and, equipped with a grab or clam-shell bucket, can unload bulk material rapidly, or with hooks instead of the buckets can take the place of the stationary crane for heavy weights or bulky material.

At a terminal where electricity will be exclusively employed, such a floating crane will be furnished with electric motors, and arrangements will be made for "plugging in" at convenient intervals.

Miscellaneous freight-handling appliances and those of more universal application, may be considered under three classes.

The first is the ship's winch, which, when there are several operating at one hatch, gives good economy, and would give a fair rapidity were it not for the congestion at the place of landing upon the pier. In some cases a platform is pushed out from the side of the pier at the first or second story for the reception of these miscellaneous packages.

Realizing the great disadvantage of this congestion and the limitation of the ship's winch the engineers at all important foreign ports have installed cranes of the traveling gantry type. In some cases, as at Hamburg, over 130 of these cranes have been installed around a single dock at a total cost of over $600,000 (£123,000). It is proved by this universal custom abroad that it is not profitable for ships to use their winches on account of the detention of the ship. As the charter value of a ship may be $400 (£82) or more per day, the saving in the time of loading and discharging is of financial importance.

The ship's winch is confined in its action to about 6 feet from the edge of the pier. The gantry will serve a half circle of 35 feet radius. In each case the next movement involves the great expense for the manual labor of rehandling.

In working out the plans for the Montgomery Terminal it was determined to carry out the resolution according to the programme of the International Congress of Navigation, that by mechanical appliances it should be possible to serve directly all places within the limits of the terminal. This means that by mechanical appliances it should be possible to transfer the freight between the vessel and any portion of the pier or pier shed, including tiering, or the bulkhead, the car platforms, the dray areas and platforms, the warehouse yards, marginal way and the industrial section continuously, rapidly and without rehandling.

To achieve these conditions of far distant hoisting and conveying it has been determined to use "transferage" or cross-space conveying, and to install movable tracks, whereby one movable track, at a far less expense, would replace many stationary, cross-gridironing tracks of the older methods, serving all space by the machinery which no stationary tracks could do.

To secure these results most satisfactorily the best type of connection between the fixed and movable cross tracks was selected. One of these types of switches is called a glider, or gliding switch, and another the opening glider, which latter permits the transferring machinery to pass by the switch, continuing in a straight line, or to take a movable cross-over or the movable loop track. This latter type is controlled by the transferman from his cab.

All parts of the terminal, including the industrial section, are connected by the above overhead runways, and also by surface railroad tracks for full carloads. The industrial sections are also connected with the berthing locations of the waterfront, all railway platforms and the team track section.

According to this arrangement freight when delivered upon the piers, bulkheads, marginal way, if a carload lot, is conveyed by surface railway to its destination about the terminal. A small waterborne consignment, or portion of a mixed carload, is transported directly to its place by overhead runways, whether to the shed, warehouse or factory. This ease and flexibility of shipping and receiving goods make the industrial sections remote from the waterfront equally valuable with those adjoining the marginal way.

The number of tractors and transfer trailer hoists will depend upon the tonnage to be transferred, and any or all of the tractors and transfers can be concentrated at any portion of the terminal for quick transferring. At some locations the transferage system will be supplemented by the walking gantry crane, and at others by the ship's winch. Hinged loops, or movable projection loops, will be arranged to extend over the ship's hatches and decks and also to serve barges and lighters.

The great points of advantage which such a terminal possesses are its great land area, its railroad connections, its location and the superiority of its transferring machinery, so as to secure the lower transhipment costs and less ship detention, due to the rapidity of loading and discharging by such appliances.

Quarterly Report of Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		May 1.	Aug. 1.
Wyoming	27,000	20½	Wm. Cramp & Sons	97.0	99.3
Arkansas	27,000	20½	New York Shipb'g Co	96.0	99.3
New York	28,000	21	Navy Yard, New York	35.3	48.2
Texas	28,000	21	Newport News Shipb'g Co	61.0	72.1
Nevada	28,000	20½	Fore River Shipb'g Co	0.0	4.0
Oklahoma	28,000	20½	New York Shipb'g Co	0.7	3.3

TORPEDO BOAT DESTROYERS

Jarvis	742	29½	New York Shipb'g Co	80.2	90.8
Henley	742	29½	Fore River Shipb'g Co	75.1	93.6
Beale	742	29½	Wm. Cramp & Sons	78.9	97.0
Cassin	742	29½	Bath Iron Works	15.6	42.3
Cummings	742	29½	Bath Iron Works	15.5	30.7
Downes	742	29½	New York Shipb'g Co	10.7	16.4
Duncan	742	29½	Fore River Shipb'g Co	18.1	34.3
Aylwin	742	29½	Wm. Cramp & Sons	18.4	48.0
Parker	742	20½	Wm. Cramp & Sons	16.4	42.2
Benham	742	29½	Wm. Cramp & Sons	17.1	38.9
Balch	742	29½	Wm. Cramp & Sons	14.4	37.3

SUBMARINE TORPEDO BOATS

F-3	....	....	Seattle Con. & D. D. Co	91.3	99.9
F-4	....	....	Seattle Con. & D. D. Co	90.6	90.8
G-4	....	....	Wm. Cramp & Sons	73.5	79.5
G-2	....	....	Newport News Shipb'g Co	85.8	86.0
G-1	....	....	Lake T. B. Co	90.2	91.1
H-1	....	....	Union Iron Works	66.3	76.2
H-2	....	....	Union Iron Works	66.5	75.7
H-3	....	....	Seattle Con. & D. D. Co	63.6	73.3
G-3	....	....	Lake T. B. Co	46.6	54.9
K-1	....	....	Fore River Shipb'g Co	30.8	43.9
K-2	....	....	Fore River Shipb'g Co	30.1	43.4
K-3	....	....	Union Iron Works	36.6	47.9
K-4	....	....	Seattle Con. & D. D. Co	30.2	40.7
K-5	....	....	Fore River Shipb'g Co	13.5	26.2
K-6	....	....	Fore River Shipb'g Co	13.5	25.8
K-7	....	....	Union Iron Works	17.5	28.2
K-8	....	....	Union Iron Works	17.5	28.2

COLLIERS

Proteus	20,000	14	Newport News Shipb'g Co	54.8	61.9
Nereus	20,000	14	Newport News Shipb'g Co	46.9	56.7
Orion	20,000	14	Maryland Steel Co	77.1	99.9
Jason	20,000	14	Maryland Steel Co	36.9	47.7
Jupiter	20,000	14	Navy Yard, Mare Island	62.0	78.2

The New Floating Dry-Docks for the British Admiralty

BY FREDERICK C. COLEMAN

The two floating docks ordered some two years ago by the British Admiralty for the accommodation of dreadnought and super-dreadnought battleships—one for Sheerness from Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne, and the other, to be stationed at Portsmouth, from Messrs. Cammell Laird & Company, Ltd., of Birkenhead—have now been completed, and in the accompanying engravings is illustrated the Sheerness Dock. This dock, like that for Portsmouth, has been built from the designs of Messrs. Clark & Standfield, of Westminster, and it is of the "box" type, with two side walls; that is to say, on each side of the pontoon proper and running almost the full length of it there is erected a side wall. Not only are these side walls permanently attached to the pontoon but the dock cannot be taken apart in any other way. This broadly constitutes the difference between the "box" dock and docks of the "self-docking" type. The latter are built in detachable sections, so that one or more portions of the dock can raise the remainder for purposes of cleaning, painting and repairing.

The dock illustrated is intended for working in connection with the Chatham Dockyard, and it has been berthed at moorings specially laid down by the British Admiralty in Salt Pan Reach, in the River Medway, near Port Victoria, Sheerness. From the dimensions on the drawings of the dock (not shown) the dock is 680 feet in length over platforms, 640 feet ¾ inch in length over the pontoons, and 144 feet ¾ inch in width. The clear width between the rubbing timbers on the top deck is 113 feet. The side walls are 65 feet 6⅝ inches in height on the outside of the dock and 46 feet 5⅞ inches above the pontoon. In length they are 520 feet ¾ inch along the pontoon deck and 440 feet ¼ inch at the top. The depth of the pontoon is 19 feet 6¾ inches. The total area occupied by the dock is no less than 2¼ acres.

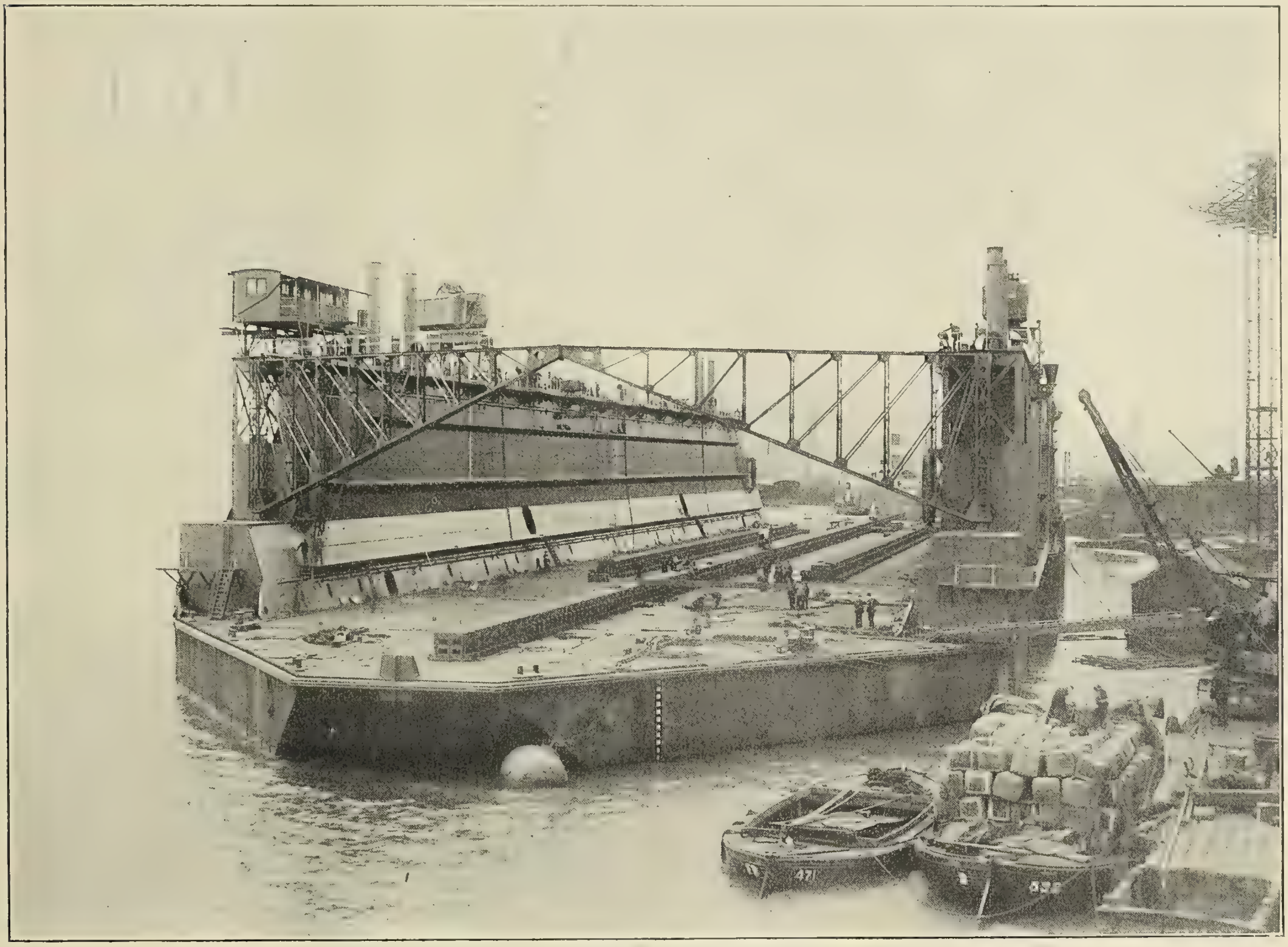


FIG. 1.—GENERAL VIEW OF 32,000-TON ADMIRALTY FLOATING DRY-DOCK

Fig. 4 affords a good view of an early stage in the construction, as it shows the bottom plating entirely laid and some of the bulkheads of the bottom pontoon erected. The height of these bulkheads, or, in other words, the depth of the pontoon, is 19 feet 6¾ inches. Overhead are shown the four great cantilever electric traveling cranes, which have proved invaluable in lifting material for the dock and placing it in position. It was under the great building shed shown on the left side of some of the illustrations that the *Mauretania* was built. The weight of steel plates and angles worked into the dock amounts to about 12,000 tons. The keel blocks, of English oak, are spread over a length of 640 feet, and the two lines of bilge blocks on each side cover a length of 280 feet, and Fig. 1, which is from a photograph taken from one end

of the dock as she was moored, shows the arrangement of the three lines of keel blocks and also gives a good idea of the length of the dock. At the bow end of the dock there is a pair of flying gangways of lattice construction, giving access from one wall to the other.

The mooring arrangements are unusually large and strong so as to efficiently hold the dock in a tideway. At each end of each wall there is a strong timber roller fender to assist in the guiding of vessels when being docked. Up the face of each wall are accommodation ladders, giving access from the pontoon dock to the top of the walls, and details of these are shown in Fig. 4, which also illustrates the three platforms which run along the inside of each wall below the top decks.

FIG. 2.—LATHE SHOP IN STARBOARD WALL OF ADMIRALTY DOCK

At the forward end of the starboard wall is placed the valve house, from which are controlled all the valves and pumping arrangements for the various compartments of the dock.

The valve operating gear is of the Westinghouse electro-pneumatic system, which has been in use for the working of points and signals on railways in all parts of the world since 1892, and has since been adopted for the operation of the water valves on floating docks. The presses are operated by air, compressed to five or six atmospheres, and controlled by means of valves operated by an electro-magnet. When the magnet is energized (*i. e.*, after the slide lever in the valve house has been pulled over) the exhaust passage of the valve is closed and the inlet opened, and the air passes into the press and thereby lifts the hydraulic valve. The position of this apparatus is indicated back to the valve house by means of the circuit breaker shown to the left of the press, the arm of which has the same travel as the press and hydraulic valve. All the time the magnet remains energized the valve is lifted, but when the current is cut off by the movement of the slide lever in the valve house the air is expelled by the weight of the valve and rod. Should the electric current fail the electro-magnets can be operated by hand, and also, if the air pressure should fail, the valve can be opened by the hand-lifting gear provided above the stirrup of the press.

The bottom pontoon is divided both longitudinally and transversely by a number of watertight bulkheads, and the two side walls each have a watertight deck running along their whole length. These bulkheads and decks divide the pontoon and walls into about eighty watertight compartments. These are grouped into sections, each of which has its own set of valves, so that it can be flooded or emptied independently. Telephones connect the various machine spaces with the principal control station.

In the port wall there is living accommodation for the dock master, petty officers and dock crew, and also messrooms, lavatories, etc.

At each end of each wall are two steam boilers, each working at a pressure of 155 pounds per square inch, and all of these were built at the Neptune Works of Messrs. Swan, Hunter & Wigham Richardson, Ltd.

The pumping machinery comprises eight sets of compound diagonal type steam engines with eight sets of 16-inch vertical standard centrifugal pumps, supplied by Messrs. Gwynnes, Ltd., of the Hammersmith Iron Works, London, and working at 275 revolutions per minute. In each wall are also placed two direct-acting Worthington steam pumps, capable of delivering 400 gallons of water a minute, and these are intended for fire and wash-down service.

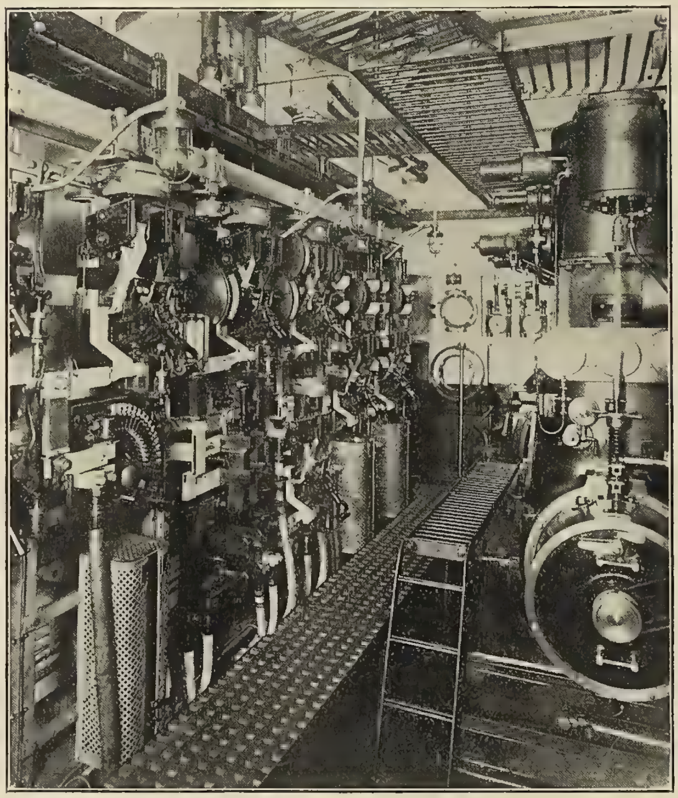


FIG. 3.—DYNAMO ROOM

In order to warp ships into position eight powerful steam-driven capstans, by Messrs. Hartfields, of London, are fitted on the walls, and there are also placed on top of the walls two 5-ton electric cranes, supplied by Messrs. Joseph Booth & Bros., Ltd., of Rodley, Leeds, each capable of working through a radius of 60 feet.

Fig. 3 is a view of the dynamo room to be found in each wall. The machinery consists of duplicate sets of Messrs. Browett, Lindley & Company's two-crank compound enclosed engines, running with forced lubrication at 400 revolutions per minute, and each driving a Westinghouse direct-current gen-

erator. The engines have cylinders 16 inches and 24 inches diameter by 10 inches stroke, and they are mounted on an under-base, which also carries the generator. They are fitted with a shaft-throttle governor, also an emergency safety governor, which can be worked either by hand or automatically from the main governor when the speed increases 10 percent. The pistons are fitted with restrained type piston rings. The piston rod and valve rods for both high-pressure and low-pressure cylinders are fitted with metallic packing. Each set is capable of developing 310 brake-horsepower (210 kilowatts) as a normal load with 140 to 150 pounds steam pressure working non-condensing, an overload of 10 percent for two hours with 110 pounds steam pressure, condensing and non-condensing, also to develop full load with 100 pounds steam pressure and 50 percent overload for short periods with increased steam pressure.

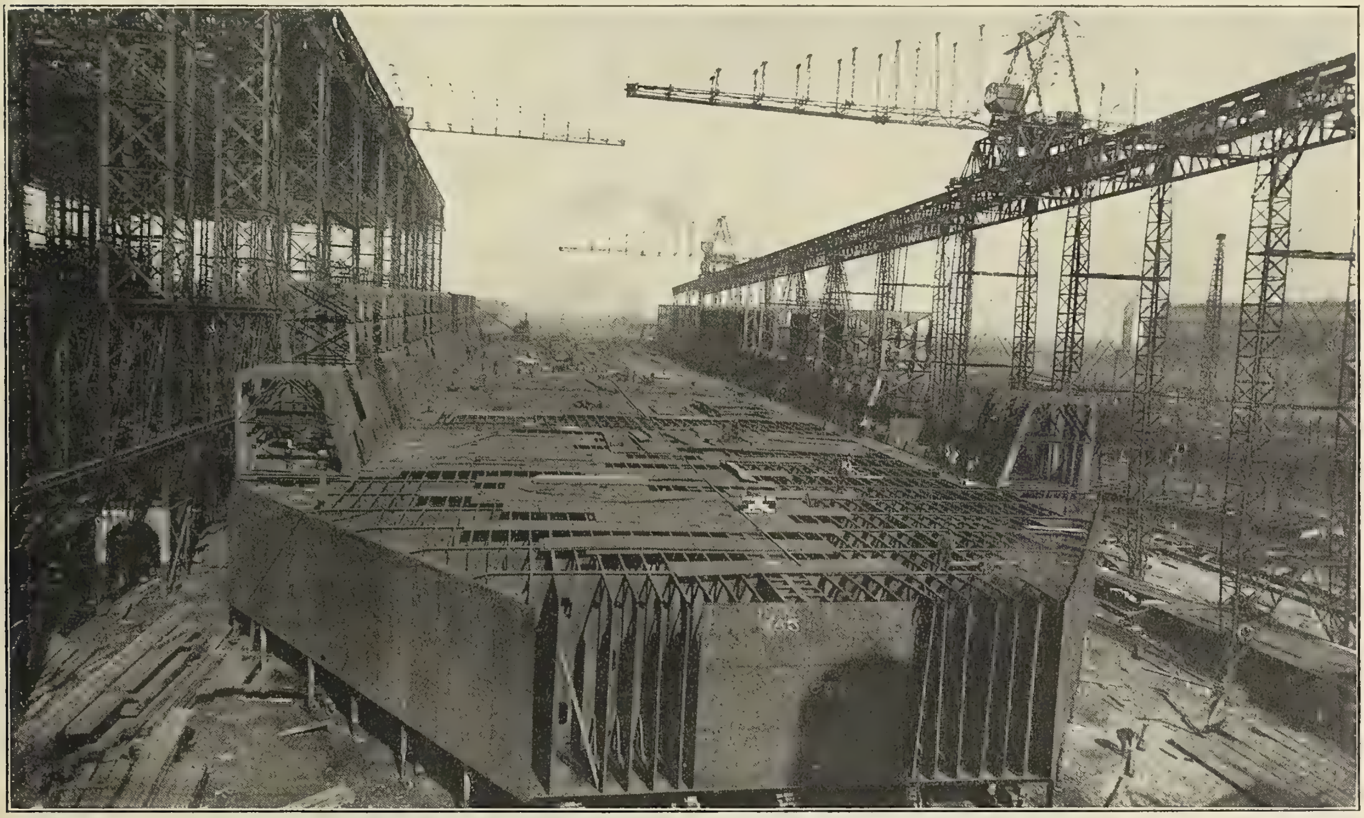


FIG. 4.—DOCK UNDER CONSTRUCTION, SHOWING SUBDIVISION OF BOTTOM PONTOON AND SIDE WALLS

This equipment of electrical machinery supplies current for driving the machinery in the workshops, the traveling cranes, the valve gear, lighting, etc., and also power and light for any warship that may be in the dock. At the top of the walls are placed large electric arc lamps hanging from revolving standards, and in addition to these there are numerous portable clusters of lamps.

In each wall of the dock there is an air compressor, supplied by Messrs. Alley & Maclellan, of Glasgow, which provides power for the electric pneumatic valve operating gear, and also pneumatic tools, of which there is a complete equipment.

In the starboard wall there is a complete range of workshops, comprising a smithy, lathe shop, machine shop and coppersmiths' shop. In the smithy is a flanging machine, by Messrs. Bertrams, of Edinburgh; punching and shearing machines, by Messrs. Hulse & Company, Ltd., of Manchester; smiths' forges, by Messrs. Alldays & Onions Pneumatic Engineering Company, Ltd., of Birmingham, and a 5-cwt. power hammer, by Messrs. Peter Pilkington, Ltd., of Preston, Lancs. In the lathe shop are five center high-speed lathes and one 6-foot chock lathe, all supplied by Messrs. Dean, Smith & Grace, Ltd., of Keighley, Yorks., and one horizontal boring and milling machine by John Holroyd & Company, Ltd., of Milnrow, near Rochdale. In the machine shops are various machines for milling, drilling and planing, and also a belt-driven hack-saw. In the coppersmiths' shop is a hydraulic copper pipe-bending machine, supplied by the Leeds Engineering & Hydraulic Company, and two coppersmiths' hearths, by Messrs. Alldays & Onions.

The dock is designed to lift battleships up to displacements of 32,000 tons, having a maximum draft of 36 feet, and was built at a cost of approximately $1,314,000 (£270,000).

The dock left the Tyne in the middle of June, and was towed to the Medway in charge of four tugs of Messrs. L. Smit & Company's Sleepdienst, Ltd., of Rotterdam.

We understand that the departmental committee recently appointed by the president of the Board of Trade to advise on the watertight subdivision of merchant ships of all classes, is now about to consider the question of the construction and fitting of watertight doors. Those makers who desire to bring their inventions to the notice of the committee can do so by writing, in the first instance, to the secretary of the bulkheads committee, Board of Trade, Whitehall Gardens, London, giving an outline of what they wish the committee to consider with relative papers. It would be well for inventors who are not engineers or naval architects to take expert advice before sending in their proposals.

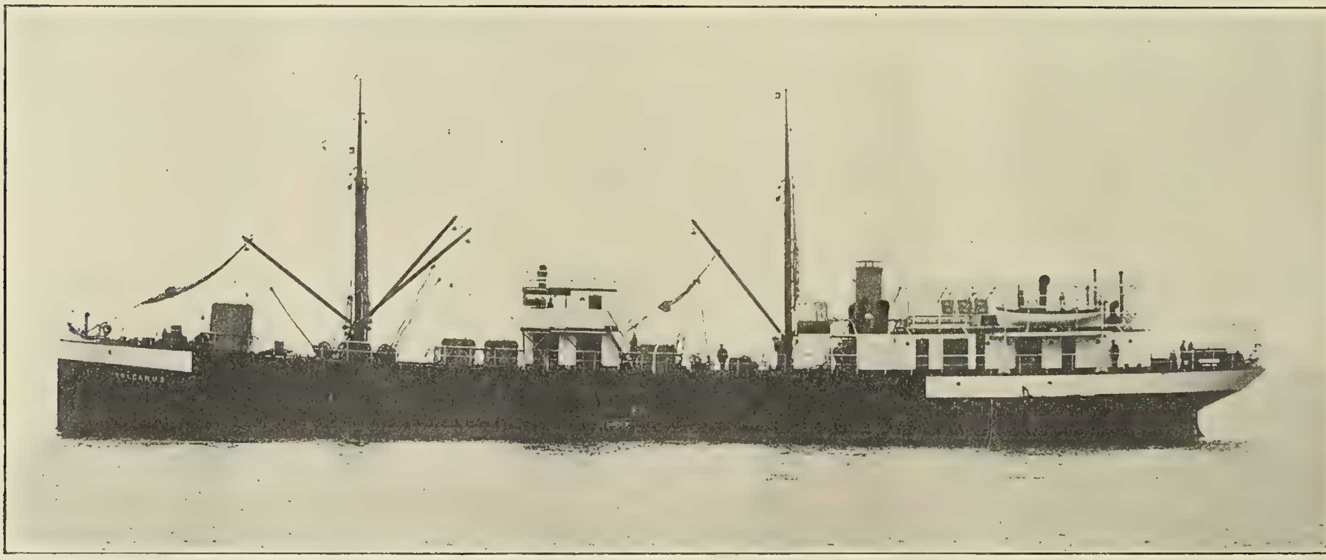
The Bureau of Navigation reports 191 sailing, steam and unrigged vessels of 28,241 gross tons built in the United States and officially numbered during the month of July. Of these five steel steamers, aggregating 4,505 gross tons, were built on the Atlantic and Gulf coasts, and six, aggregating 5,288 gross tons, were built on the Great Lakes.

Performance of Notable Sea-Going Diesel Engined Vessels

BY F. MULLER VAN BRAKEL

From time to time International Marine Engineering has published articles describing ships propelled by Diesel engines. Most of the ships mentioned have been either auxiliary motor ships (as, for instance, the splendid big sailing vessels *Queville* and *France* or smaller craft for river or coastwise use. With the exception of the *Toiler* and the *Selandia* no real sea-going cargo traders have been described. But if the Diesel engine is going to revolutionize the shipping world it should be capable of driving the ordinary cargo boat—that is, the tramp. Small, high-speed Diesel engines, as constructed in Germany for submarines, may be very useful, but a new type of propelling machinery for cargo carriers is of far greater importance.

In the following a description will be given of the ocean-going cargo boat *Vulcanus,* which is propelled by Werkspoor Diesel engines. This description will be followed by a brief account of the experiences with this boat at sea, by some particulars from the fuel bill and by the opinion of the ship-owners, as expressed in the order book of the Werkspoor Works.



DIESEL ENGINED CARGO BOAT VULCANUS

The Hull

The *Vulcanus* was built by the Nederlandsche Shipbuilding Company, Amsterdam, to the order of the Anglo Saxon Oil Company. It is an oil-tank ship of the turret-deck type, 196 feet by 37 feet 9 inches by 13 feet 2½ inches, displacing, when fully loaded, 1,900 tons. Its deadweight capacity at the maximum draft of 7 feet 6 inches is 1,000 tons. There is a short bridge deck house amidships and another deck house aft for the accommodation of the officers, pilot, etc. Two short pole masts are fitted with loading tackle to handle the cargo when no oil is carried. The four windlasses and the winch are driven by compressed air, which in a Diesel ship is always at hand. The engine room is aft, and as the combustion gases are discharged through a funnel the ship looks very much like a steamer, except that the funnel never gives out any smoke.

The hull, built to Lloyd's highest class, is similar to the ordinary tank vessel with a longitudinal bulkhead and several transverse bulkheads, which divide the hull into cargo holds, a pump room and engine room. Two cofferdams are built, one forward and one aft of the cargo space.

Propelling Machinery

The engines and auxiliaries were designed and built by the Werkspoor Works, of Amsterdam. This firm has for many years engined a great number of passenger and cargo steamers, and for the last fifteen years has taken up the construction of Diesel engines. The experience gained by the construction of marine steam engines was of great benefit when the oil engines for the *Vulcanus* were designed, because the knowledge and skill of the men who will have to handle the machinery should be taken into account when a ship is fitted out with a new type of engine. The Werkspoor Works, therefore, endeavored to design a Diesel engine which, besides proving reliable, would conform as closely as possible to the marine steam engine, especially in the design of details. The result was an engine whose details were at once quite familiar to the marine steam engineer, who is accustomed to short pistons with rods and cross-heads and eccentrics and eccentric rods, all of which are found in the Werkspoor Diesel engines, so if any accidents happen the engineer will know from experience how to tackle the job.

The principal differences in construction between the Werkspoor marine Diesel and other Diesel motors are, briefly:

(1) The trunk piston with many rings has been replaced by a rather short piston, not subjected to any side thrust but fitted with piston rod and cross-head.

(2) The camshafts are not driven by vertical transmission shafts and spiral gears but by means of a pinion working on two spur wheels fitted, respectively, on the camshaft for ahead and on that for astern motion.

(3) The vertical shaft has been replaced by two eccentric rods.

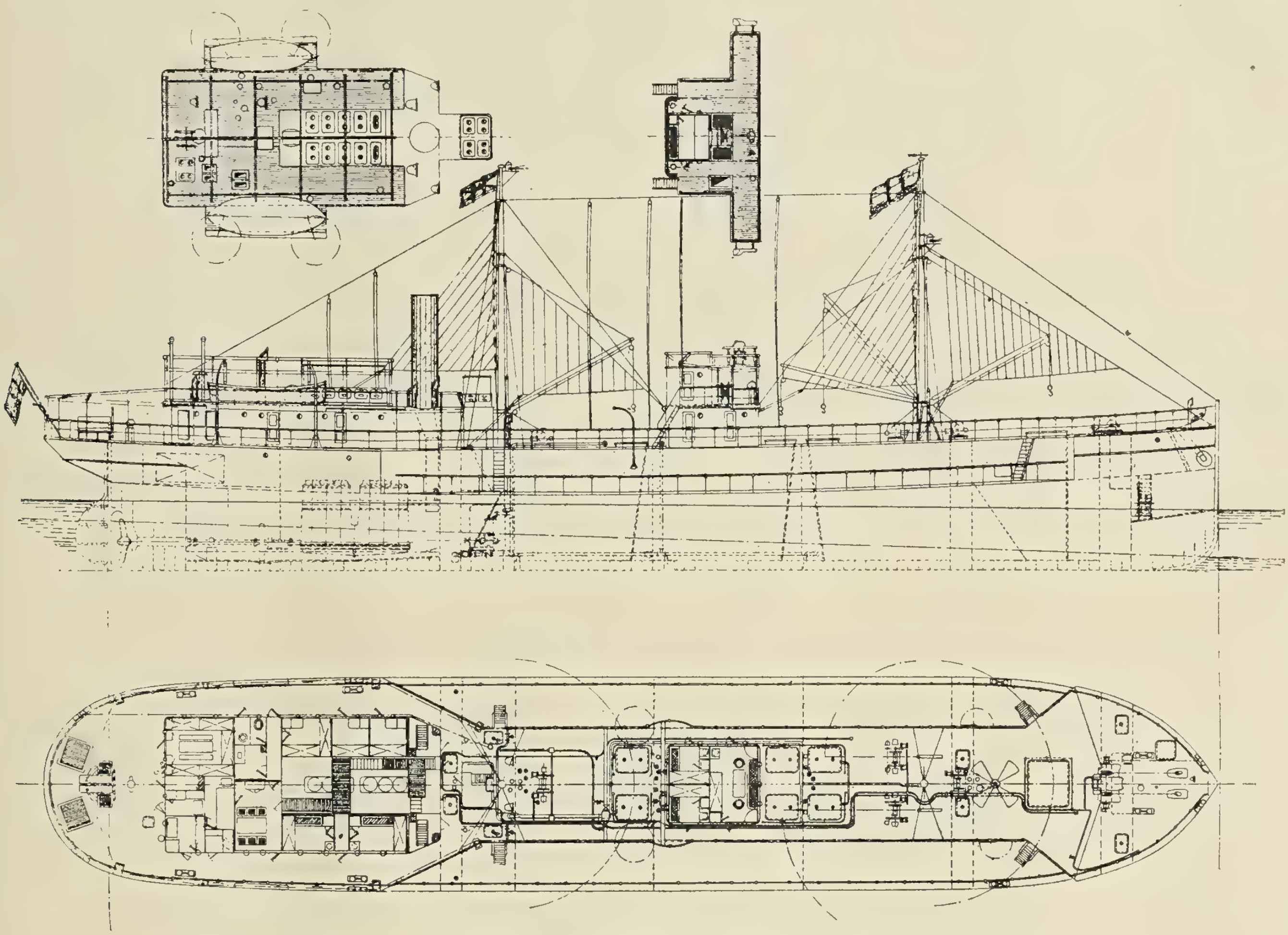
The main engine is a single-acting, four-cycle motor, developing 500 horsepower at 165 revolutions per minute. The low number of revolutions will be appreciated by engineers who have had to design propellers for slow-speed motor boats. The six cylinders are 15¾ inches diameter by 23½

inches stroke. Air, fuel, exhaust and starting valves are arranged in the ordinary way, but are driven by a new arrangement permitting the engine to be reversed. There are two camshafts, one for ahead and one for astern motion, running in bearings which are fitted in the arms of V-shaped brackets. These V brackets can rotate around the center of a reversing shaft which corresponds to the tip of the V. Thus by rotating the reversing shaft the ahead or astern camshaft is brought in position to actuate the valve levers. The spur wheels, keyed on the camshafts, are both driven continuously by one pinion, which is fitted on a small two-crank shaft, which in its turn is rotated by two eccentric rods from the main shafting. The other details of the engine follow the usual Diesel engine practice. Each cylinder has two fuel pumps—one for injecting the oil, the other being a spare one. The air compressor, the cooling water pump and the bilge pumps are situated at the back of the engine. The front of the engine shows the hand-wheel for rotating the reversing shaft and the handles controlling the admission of fuel and compressed air. Here, again, the marine engineer will feel quite at home. A separate 50-horsepower Diesel engine drives the air compressor for filling the air tanks, while a 10-horsepower kerosene (paraffin) motor drives the electric generator for lighting the ship. These are the only auxiliaries.

Troubles and Results

A rather complete account of the troubles and experiences during the first voyages of the *Vulcanus* was given at the April meeting of the Institution of Naval Architects by Mr. C. Kloos, constructing manager of the Werkspoor Works. It may be repeated here:

"On the first voyage from Rotterdam to Hamburg and back a slight trouble was experienced with the air pumps, which could be remedied easily. During the second voyage to Aranton an air pump lever snapped owing to the extra strains put on it by water coming down the funnel during a heavy gale. When stronger levers were made no trouble was experienced from this source. There was also trouble with some piston rings "sticking" as a consequence of incomplete combustion. This was caused by a gauze wire covering the air in-take pipe, which was choked and prevented the entry of sufficient air. After the third voyage some minor alterations were made, but overhauling was found unnecessary. Since then the *Vulcanus* has remained in regular service and made many voyages on the Baltic, Mediterranean and Black seas."



GENERAL ARRANGEMENT PLANS OF THE VULCANUS

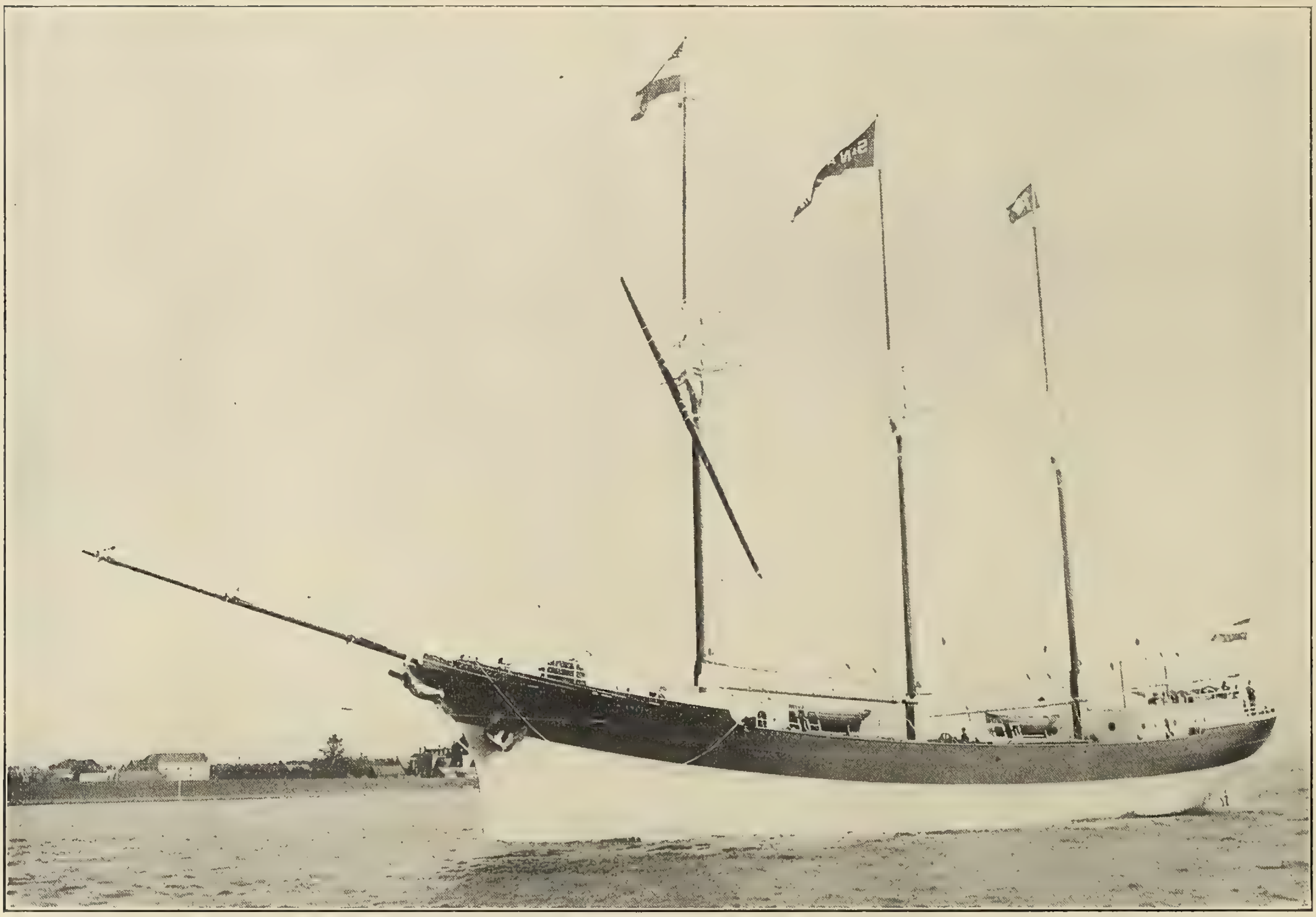
Fuel Consumption

Concerning fuel consumption the owners gave the following account of a voyage to Sweden:

Rotterdam to Stockholm—Cargo, 1,000 tons gasoline (petrol); distance, 735 miles; duration, 100 hours; consumption, 7,390 kg. crude oil; consumption per 100 miles, 1 ton crude oil.

Stockholm to Rotterdam—Cargo, 500 tons water ballast; distance, 735 miles; duration, 98 hours; consumption, 16,100 pounds crude oil; consumption per 100 miles, 1 ton crude oil; fuel costs for 100 miles with 1,000 tons cargo, $10.50-$12.00 (£2 3s. to £2 10s.).

This confirms the Werkspoor statement that in ordinary practice the transport of 1,000 tons of cargo does not cost more than $12.00 (£2. 10s.).



AUXILIARY SCHOONER SAN ANTONIO, FITTED WITH A NON-REVERSING DIESEL MOTOR

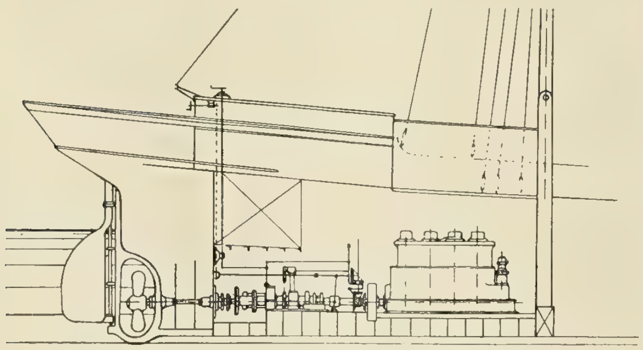
Prospects

These results speak for themselves. A still more reliable test of these engines is given by the order book of the Werkspoor Works. It gives unmistakable evidence of the trust put in these engines by the owners of the *Vulcanus* and by others who watched its proceedings.

The following ships were, or are to be, equipped with Werkspoor Diesel engines:

Vulcanus—Owners, Anglo Saxon Oil Co.; dimensions, 196′ 0″ x 37′ 9″ x 13′ 2½″ x 7′ 6″ draft; 1,900 tons displacement; engines, 6-cylinder, 15¾″ x 23⅝″, 500 H. P. at 165 revolutions, 8½ knots.
San Antonio—Owners, S. Hammerstein, Rotterdam; dimensions, 154′ 0″ x 26′ 10″ x 12′ 3″ x 11′ 5″ draft; 500 tons displacement; engine, non-reversible, 4 cylinder, 200 H. P. at 180 revolutions (auxiliary).
Cornelis—Dimensions, 154′ 0″ x 26′ 10″ x 12′ 5″ x 10′ 8″ draft; engine, 4-cylinder, 200 H. P. at 180 revolutions.
Sembilan—Owners, Royal Packet Line, Amsterdam; dimensions, 152′ 0″ x 26′ 0″ x 9′ 6″ x 7′ 0″ draft.
Building—Owners, Anglo Saxon Oil Co.; dimensions, 258′ 0″ x 48′ 0″ x 19′ 8″ x 18′ 6″ draft; 4,250 tons displacement; engine, 6-cylinder, 1,100 H. P. at 175 revolutions.
Building—Owners, S. A. d'Armement et de Commerce, Antwerp; dimensions, 375′ 0″ x 51′ 0″ x 29′ 0″ x 23′ 0″ draft; 9,300 tons displacement; engines, twin screw, 2 x 6 cylinders, 2 x 1,100 H. P. at 170 revolutions; 8½ knots.

Moreover, it is said that a well-known line of steamers is about to order three twin-screw ships of from 2,000 to 1,100 horsepower each.



SECTION OF ENGINE ROOM OF THE SAN ANTONIO

Non-Reversing Type

Besides reversible Diesel engines the Werkspoor Works is building smaller non-reversing motors as auxiliaries for sailing vessels. This type is built from 160 to 400 brake-horsepower, and is fitted invariably with a reversible screw propeller. The power wanted for changing the position of the blades is given by the engine itself, and a clutch is provided if desired. The working of the clutch is performed by hand; both clutch and propeller blade mechanism can be worked from deck or in the engine room. When no clutch is fitted it is sometimes difficult to steer the ship when the angle of the blades is zero. An arrangement is therefore made allowing the number of revolutions to be cut down to one-half.

The engines are four-cylinder, four-cycle box frame motors. The working speed is controlled by a governor, but at the moment the position of the blades is changed the admission of fuel to the engine can be throttled by hand also. The bilge and ballast pumps are driven from an intermediate shaft geared from the main crank-shaft. An auxiliary air compressor is driven by a small kerosene (paraffin) motor, which can be started by hand. The following table shows the sizes:

FOUR-CYLINDER MARINE DIESEL ENGINES. PROPELLERS WITH REVERSING BLADES.

B. H. P.	Revolutions.	Weight A.		Weight B.		Total Weight.	
		Tons	Cwt.	Tons	Cwt.	Tons	Cwt.
100	270	11	16	3	10	15	6
130	260	15	..	3	18	18	18
160	250	19	4	4	4	23	8
200	240	24	..	4	16	28	16
250	230	30	10	5	8	35	18
325	220	40	10	6	4	46	14
400	210	51	..	7	2	58	2

Weight A includes: Engine, ballast, bilge and cooling water pumps and air vessels.
Weight B includes: Reversing mechanism, propeller and shaft.

The first ship fitted with this type of engine is the *San Antonio*, a three-masted schooner (see the above table from order book), which has given a good account of herself on a voyage to Brazil and return, when the engine was in operation constantly.

The Sol Duc

The steamship *Sol Duc*, recently built by the Seattle Construction & Dry Dock Company, Seattle, Wash., for the Inland Navigation Company, is one of the finest vessels owned by this company. It is expected that the vessel will play an important part in carrying tourists to the several pleasure resorts on Olympic Peninsula, the most important of which is Sol Duc Springs, where a palatial hotel has just been completed.

Accommodations are provided on the *Sol Duc* for about 163 passengers in forty-nine staterooms, and there is a freight capacity of 14,000 cubic feet on the main deck.

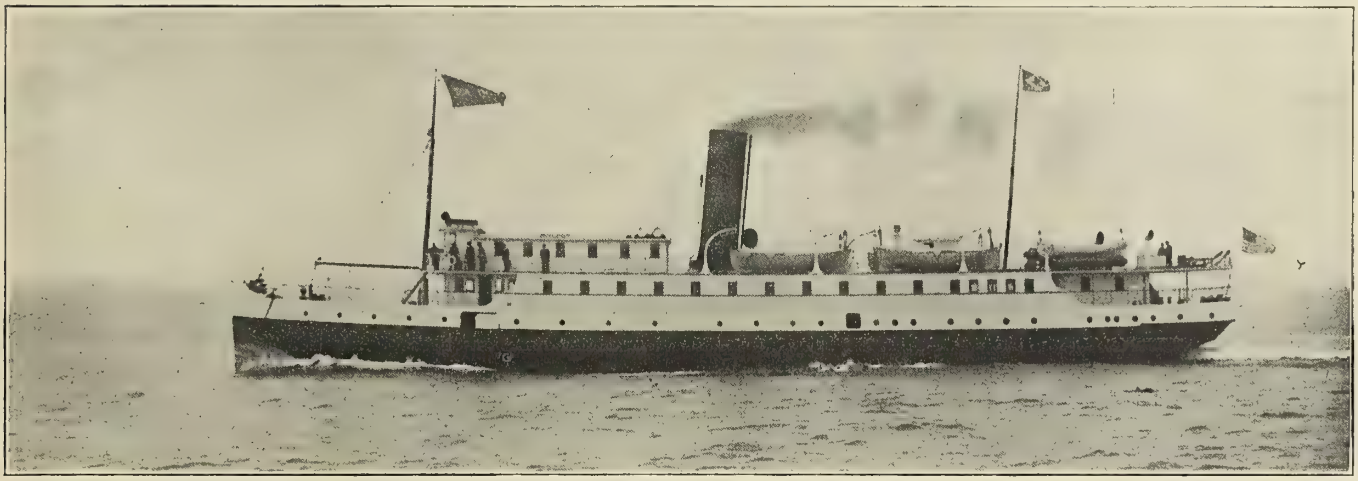
The hull is built of mild steel, and has five watertight bulkheads extending to the main deck. Following are the principal hull dimensions:

Length over all	205 feet.
Length between perpendiculars	195 feet.
Breadth, molded	32 feet.
Mean draft (on trial trip)	9 feet 9¼ inches.
Displacement (on trial trip)	795 tons.

There are four decks, all laid of wood, viz.: the boat, upper, main and lower decks. On the boat deck are located the pilot house, the captain's quarters, the mate's quarters, ten staterooms, the wireless operator's cabin and quarters, and the lifeboats and rafts. Directly below on the upper deck there is an observation room forward, twenty-nine staterooms amidships and a social hall aft. The galley, the engineer's quarters, the chief steward's quarters, ten staterooms and cargo space occupy the entire space on the main deck, while the dining saloon, pantry and storeroom are on the lower deck aft. Forward of the machinery space on this deck are the bar and smoking room and the crew's quarters.

Steam for the propelling and auxiliary machinery is supplied by two Ballin watertube boilers of 5,000 square feet total heating surface. These boilers are fitted with Staples & Pfeiffer burners and burn oil fuel under natural draft.

The main engine has cylinders 17 inches, 28 inches and 47½ inches diameter by 36 inches stroke. The propeller is 11 feet in diameter by 15 feet 6 inches pitch. The condenser is of the indpendent type, and has a cooling surface of 1914 square feet. A 10-inch centrifugal circulating pump, of the Seattle Construction & Dry Dock Company's make, supplies cooling water for the condenser. The air pump is attached to the main engine.



NEW PASSENGER STEAMER SOL DUC

The following auxiliaries were installed:

Two vertical duplex main feed pumps, made by M. T. Davidson Company.

One horizontal duplex fire and bilge pump, made by George F. Blake Manufacturing Company.

One horizontal duplex sanitary pump, male by George F. Blake Manufacturing Company.

One horizontal duplex fresh water pump, made by George F. Blake Manufacturing Company.

Two horizontal duplex oil fuel pumps, made by Fairbanks, Morse & Company.

One Reilly multi-coil feed-water heater.

One 7-kilowatt, direct-current Westinghouse generator set.

One 20-kilowatt, direct-current Westinghouse generating set.

The oil fuel compartments have a capacity of 1,200 barrels.

The average results of the speed trial on the measured mile off Vashon Island were as follows:

Speed, knots	15.37
Revolutions per minute	120
Boiler pressure, pounds	215
Steam pressure at high-pressure receiver, pounds	208
Steam pressure at intermediate-pressure receiver, pounds	76
Steam pressure at low-pressure receiver, pounds	13.5
Vacuum, inches	25.2
Indicated horsepower	1,515
Slip of propeller, percent	16.34
Revolutions per minute of circulating pump engine	216

On the trial trip, in addition to the standardization runs, an endurance run of four hours was made, and the performance of the vessel was very satisfactory.

Final Reports of Titanic Inquiries in America and England

Although considerable time has elapsed since the final report of the *Titanic* investigation in America was made public, we have withheld publication of the conclusions of this inquiry until the subsequent investigation in England had been completed, so that the recommendations of both could be compared and any further information brought out in the latter which might have some bearing on these recommendations could be included. While the report from the British inquiry is by far the longer document, covering every phase of the disaster, it contains little information that would contradict or add materially to the facts brought out in the American investigation, except that in England the builders of the vessel were at hand, and a thorough examination of the disaster from a professional standpoint could be carried out and a better knowledge of the extent of the damage to the vessel and the consequent behavior of the vessel could be determined which was not possible in America.

The American inquiry was conducted by the United States Senate Committee on Commerce, Mr. William Alden Smith, of Michigan, chairman. The recommendations contained in its report are as follows:

Recommendations of United States Committee

The committee finds that this accident clearly indicates the necessity of additional legislation to secure safety of life at sea.

By statute the United States accepts reciprocally the inspection certificates of foreign countries having inspection laws approximating those of the United States. Unless there is early revision of inspection laws of foreign countries along the lines laid down hereinafter, the committee deems it proper that such reciprocal arrangements be terminated, and that no vessel shall be licensed to carry passengers from ports of the United States until all regulations and requirements of the laws of the United States have been fully complied with.

Lifeboats

The committee recommends that sections 4481 and 4488, Revised Statutes, be so amended as to definitely require sufficient lifeboats to accommodate every passenger and every member of the crew. That the importance of this feature is recognized by the steamship lines is indicated by the fact that on many lines steps are being taken to provide lifeboat capacity for every person on board, including crew, and the fact of such equipment is being widely advertised. The president of the International Mercantile Marine Company, Mr. Ismay, definitely stated to the committee (p. 985):

"We have issued instructions that none of the ships of our lines shall leave any port carrying more passengers and crew than they have capacity for in the life-boats.

"Not less than four members of the crew, skilled in handling boats, should be assigned to every boat. All members of the crew assigned to lifeboats should be drilled in lowering and rowing the boats not less than twice each month, and the fact of such drill or practice should be noted in the log."

The committee recommends the assignment of passengers and crew to lifeboats before sailing; that occupants of certain groups of staterooms and the stewards of such groups of rooms be assigned to certain boats most conveniently located with reference to the rooms in question; the assignment of boats and the shortest route from stateroom to boat to be posted in every stateroom.

Searchlights

The committee recommends that every ocean steamship carrying 100 or more passengers be required to carry two electric searchlights.

Wireless

The committee finds that this catastrophe makes glaringly apparent the necessity for regulation of radio-telegraphy. There must be an operator on duty at all times, day and night, to insure the immediate receipt of all distress, warning or other important calls. Direct communication either by clear-speaking telephone, voice tube, or messenger must be provided between the wireless room and the bridge, so that the operator does not have to leave his station. There must be definite legislation to prevent interference by amateurs, and to secure secrecy of radiograms or wireless messages. There must be some source of auxiliary power, either storage battery or oil engine, to insure the operation of the wireless installation until the wireless room is submerged.

The committee recommends the early passage of Section 6412, already passed by the Senate and favorably reported by the House.

The committee recommends that the firing of rockets or candles on the high seas for any other purpose than as a signal of distress be made a misdemeanor.

Structural Requirements

The committee recommends that the following additional structural requirements be required as regards oceangoing passenger steamers the construction of which is begun after this date:

All steel ocean and coastwise seagoing ships carrying 100 or more passengers should have a watertight skin inboard of the outside plating, extending not less than 10 percent of the load draft above the full-load waterline, either in the form of an inner bottom or of longitudinal watertight bulkheads, and this construction should extent from the forward collision bulkhead over not less than two-thirds of the length of the ship.

All steel ocean and coastwise seagoing ships carrying 100 or more passengers should have bulkheads so spaced that any two adjacent compartments of the ship may be flooded without destroying the flotability or stability of the ship. Watertight transverse bulkheads should extend from side to side of the ship, attaching to the outside shell. The transverse bulkheads forward and abaft of the machinery spaces should be continued watertight vertically to the uppermost continuous structural deck. The uppermost continuous structural deck should be fitted watertight. Bulkheads within the limits of the machinery spaces should extend not less than 25 percent of the draft of the ship above the load waterline and should end at a watertight deck. All watertight bulkheads and decks should be proportioned to withstand, without material permanent deflection, a water pressure equal to 5 feet more than the full height of the bulkhead. Bulkheads of novel dimensions or scantlings should be tested by being subjected to actual water pressure.

The British court appointed to investigate the *Titanic* disaster was headed by Lord Mersey. Its recommendations are as follows:

Recommendations of British Court

The following recommendations are made. They refer to foreign-going passenger and emigrant steamships:

Watertight Subdivision

1. That the newly-appointed bulkhead committee should inquire and report, among other matters, on the desirability and practicability of providing ships with (*a*) a double skin carried up above the waterline; or, as an alternative, with (*b*) a longitudinal, vertical, watertight bulkhead on each side of the ship, extending as far forward and aft as convenient; or

(*c*) with a combination of (*a*) and (*b*). Any one of the three, (*a*), (*b*) and (*c*), to be in addition to watertight transverse bulkheads.

2. That the committee should also inquire and report as to the desirability and practicability of fitting ships with (*a*) a deck or decks at a convenient distance or distances above the waterline, which shall be watertight throughout a part or the whole of the ship's length; and should, in this connection, report upon (*b*) the means by which the necessary openings in such deck or decks should be made watertight, whether by watertight doors or watertight trunks, or by any other and what means.

3. That the committee should consider and report generally on the practicability of increasing the protection given by subdivision; the object being to secure that the ship shall remain afloat with the greatest practicable proportion of her length in free communication with the sea.

4. That when the committee has reported upon the matters before mentioned, the Board of Trade should take the report into their consideration, and to the extent to which they approve of it, should seek statutory powers to enforce it in all newly-built ships, but with a discretion to relax the requirements in special cases where it may seem right to them to do so.

5. That the Board of Trade should be empowered by the Legislature to require the production of the designs and specifications of all ships in their early stages of construction, and to direct such amendments of the same as may be thought necessary and practicable for the safety of life at sea in ships. (This should apply to all passenger-carrying ships.)

Lifeboats and Rafts

6. That the provision of lifeboat and raft accommodation on board such ships should be based on the number of persons intended to be carried in the ship, and not upon tonnage.

7. That the question of such accommodation should be treated independently of the question of the subdivision of the ship into watertight compartments. (This involves the abolition of Rule 12 of the Life-Saving Appliances Rules of 1902.)

8. That the accommodation should be sufficient for all persons on board, with, however, the qualification that in special cases, where, in the opinion of the Board of Trade, such provision is impracticable, the requirements may be modified as the board may think right. (In order to give effect to this recommendation, changes may be necessary in the sizes and types of boats to be carried and in the method of stowing and floating them. It may also be necessary to set apart one or more of the boat decks exclusively for carrying boats and drilling the crew, and to consider the distribution of decks in relation to the passengers' quarters. These, however, are matters of detail, to be settled with reference to the particular circumstance affecting the ship.)

9. That all boats should be fitted with a protective, continuous fender, to lessen the risk of damage when being lowered in a seaway.

10. That the Board of Trade should be empowered to direct that one or more of the boats be fitted with some form of mechanical propulsion.

11. That there should be a Board of Trade regulation requiring all boat equipment (under Sections 5 and 6, page 15, of the Rules, dated February, 1902, made by the Board of Trade under Section 427, Merchant Shipping Act, 1894) to be in the boats as soon as the ship leaves harbor. The sections quoted above should be amended so as to provide also that all boats and rafts should carry lamps and pyrotechnic lights for purposes of signaling. All boats should be provided with compasses and provisions, and should be very distinctly marked in such a way as to indicate plainly the number of adult persons each boat can carry when being lowered.

12. That the Board of Trade inspection of boats and life-saving appliances should be of a more searching character than hitherto.

Manning the Boats and Boat Drills

13. That in cases where the deck hands are not sufficient to man the boats enough other members of the crew should be men trained in boat work to make up the deficiency. These men should be required to pass a test in boat work.

14. That in view of the necessity of having on board men trained in boat work, steps should be taken to encourage the training of boys for the merchant service.

15. That the operation of Section 115 and Section 134 (*a*) of the Merchant Shipping Act, 1894, should be examined, with view to amending the same so as to secure greater continuity of service than hitherto.

16. That the men who are to man the boats should have more frequent drills than hitherto. That in all ships a boat drill, a fire drill, and a watertight-door drill should be held as soon as possible after leaving the original port of departure and at convenient intervals of not less than once a week during the voyage. Such drills to be recorded in the official log.

17. That the Board of Trade should be satisfied in each case before the ship leaves port that a scheme has been devised and communicated to each officer of the ship for securing an efficient working of the boats.

General

18. That every man taking a lookout in such ships should undergo a sight test at reasonable intervals.

19. That in all such ships a police system should be organized, so as to secure obedience to orders and proper control and guidance of all on board in times of emergency.

20. That in all such ships there should be an installation of wireless telegraphy, and that such installation should be worked with a sufficient number of trained operators to secure a continuous service by night and day. In this connection regard should be had to the resolutions of the International Conference on Wireless Telegraphy, recently held under the presidency of Sir H. Babington Smith. That where practicable a silent chamber for "receiving" messages should form part of the installation.

21. That instructions should be given in all steamship companies' regulations that when ice is reported in or near the track the ship should proceed in the dark hours at a moderate speed, or alter her course so as to go well clear of the danger zone.

22. That the attention of masters of vessels should be drawn by the Board of Trade to the effect that under the Maritime Conventions Act, 1911, it is a misdemeanor not to go to the relief of a vessel in distress when possible to do so.

23. That the same protection as to the safety of life in the event of casualty which is afforded to emigrant ships by means of supervision and inspection should be extended to all foreign-going passenger ships.

24. That (unless already done) steps should be taken to call an International Conference to consider, and as far as possible to agree upon, a common line of conduct in respect of: (*a*) The subdivision of ships; (*b*) the provision and working of life-saving appliances; (*c*) the installation of wireless telegraphy, and the method of working the same; (*d*) the reduction of speed or the alteration of course in the vicinity of ice, and (*e*) the use of searchlights.

On account of the information given by the builders of the *Titanic*, and the discussion of the technical features of the accident by other professional authorities the following account of the extent of the damage done to the ship by the collision and its effect upon the buoyancy of the vessel, given in

Lord Mersey's report, will be of interest to all shipbuilders and naval architects:

Extent of the Damage to the Ship

The collision with the iceberg, which took place at 11:40 P. M., caused damage to the bottom of the starboard side of the vessel at about 10 feet above the level of the keel, but there was no damage above this height. There was damage in the fore peak, No. 1 hold, No. 2 hold, No. 3 hold, No. 6 boiler room (the furthest forward), No. 5 boiler room. The damage extended over a length of about 300 feet.

As the ship was moving at over 20 knots she would have passed through 300 feet in less than ten seconds, so that the damage was done in about this time.

The Flooding in First Ten Minutes

At first it is desirable to consider what happened in the first ten minutes. The fore peak was not flooded above the orlop deck, i. *e.,* the peak tank top, from the hole in the bottom of the peak tank. In No. 1 hold there was 7 feet of water. In No. 2 hold, five minutes after the collision, water was seen rushing in at the bottom of the firemen's passage on the starboard side, so that the ship's side was damaged abaft of bulkhead B sufficiently to open the side of the firemen's passage, which was 3½ feet from the outer skin of the ship, thereby flooding both the hold and the passage.

In No. 3 hold the mail room was filled soon after the collision. The floor of the mail room is 24 feet above the keel.

In No. 6 boiler room, when the collision took place, water at once poured in at about 2 feet above the stokehold plates on the starboard side at the after end of the boiler room. Some of the firemen immediately went through the watertight door opening to No. 5 boiler room, because the water was flooding the place. The watertight doors in the engine room were shut from the bridge almost immediately after the collision. Ten minutes later it was found that there was water to the height of 8 feet above the double bottom in No. 6 boiler room.

No. 5 boiler room was damaged at the ship's side in the starboard forward bunker at a distance of 2 feet above the stokehold plates at 2 feet from the watertight bulkhead between Nos. 5 and 6 boiler rooms. Water poured in at that place as it would from an ordinary fire hose. At the time of the collision this bunker had no coal in it. The bunker door was closed when water was seen to be entering the ship.

In No. 4 boiler room there was no indication of any damage at the early stages of the sinking.

Gradual Effect of the Damage

It will thus be seen that all the six compartments forward of No. 4 boiler room were open to the sea by damage which existed at about 10 feet above the keel. At ten minutes after the collision the water seems to have risen to about 14 feet above the keel in all these compartments except No. 5 boiler room. After the first ten minutes the water rose steadily in all these six compartments. The fore peak above the peak tank was not filled until an hour after the collision, when the vessel's bow was submerged to above C deck. (The decks are numbered from A down to G, A being the deck immediately below the boat deck and G the one just above the orlop deck.) The water then flowed in from the top through the deck scuttle forward of the collision bulkhead. It was by this scuttle that access was obtained to all the decks below C down to the peak-tank top on the orlop deck.

At 12 o'clock water was coming up in No. 1 hatch. It was getting into the firemen's quarters and driving the firemen out. It was rushing round No. 1 hatch on G deck, and coming mostly from the starboard side, so that in twenty minutes the water had risen above G deck in No. 1 hold. In No. 2 hold, about forty minutes after the collision, the water was coming into the seamen's quarters on E deck through a burst fore-and-aft wooden bulkhead of a third class cabin opposite the seamen's wash place. Thus the water had risen in No. 2 hold to about 3 feet above E deck in forty minutes.

In No. 3 hold the mail room was afloat about twenty minutes after the collision. The bottom of the mail room, which is on the orlop deck, is 24 feet above the keel. The watertight doors on F deck, at the fore and after ends of No. 3 compartment, were not closed then. The mail room was filling, and water was within 2 feet of G deck, rising fast, when the order was given to clear the boats. There was then no water on F deck.

There is a stairway on the port side on G deck which leads down to the first class baggage-room on the orlop deck immediately below. There was water in this baggage-room twenty-five minutes after the collision. Half an hour after the collision water was up to G deck in the mail room. Thus the water had risen in this compartment to within 2 feet of G deck in twenty minutes, and above G deck in twenty-five to thirty minutes.

No. 6 boiler room was abandoned by the men almost immediately after the collision. Ten minutes later the water had risen to 8 feet above the top of the double bottom, and probably reached the top of the bulkhead at the after end of the compartment, at the level of E deck, in about one hour after the collision.

In No. 5 boiler room there was no water above the stokehold plates until a rush of water came through the pass between the boilers from the forward end, and drove the leading stoker out.

It has already been shown in the description of what happened in the first ten minutes that water was coming into No. 5 boiler room in the forward starboard bunker at 2 feet above the plates in a stream about the size of a deck hose. The door in this bunker had been dropped probably when water was first discovered, which was a few minutes after the collision. This would cause the water to be retained in the bunker until it rose high enough to burst the door, which was weaker than the bunker bulkhead. This happened about an hour after the collision.

One hour and forty minutes after the collision water was coming in forward in No. 4 boiler room from underneath the floor in the forward part in small quantities. The men remained in that stokehold till ordered on deck.

When the men left No. 4 some of them went through Nos. 3, 2 and and 1 boiler rooms into the reciprocating-engine room, and from there on deck. There was no water in the boiler rooms abaft No. 4 one hour and forty minutes after the collision (1:20 A. M.), and there was then none in the reciprocating and turbine-engine rooms.

There was no damage to the electrical engine room and tunnels.

From the foregoing it follows that there was no damage abaft No. 4 boiler room.

All the watertight doors aft of the main engine room were opened after the collision.

Half an hour after the collision the watertight doors from the engine room to the stokehold were opened as far forward as they could be to No. 4 boiler room.

Final Effect of the Damage

The later stages of the sinking cannot be stated with any precision, owing to a confusion of the times, which was natural under the circumstances.

The forecastle deck was not under water at 1:35 A. M. Distress signals were fired until two hours after the collision (1:45 A. M.). At this time the fore deck was under water.

The forecastle head was not then submerged, though it was getting close down to the water about half an hour before the ship disappeared (1:50 A. M.).

When the last boat, lowered from davits D, left the ship, A deck was under water, and water came up the stairway under the boat deck almost immediately afterwards. After this the other collapsible boat, which had been stowed on the officers' house, was uncovered, the lashings cut adrift, and she was swung round over the edge of the coamings of the deck house onto the boat deck. Very shortly afterwards the vessel, according to Mr. Lightoller's account, seemed to take a dive, and he just walked into the water. When he came to the surface all the funnels were above the water.

The stern was gradually rising out of the water, and the propellers were clear of the water. The ship did not break in two, and she did eventually attain the perpendicular, when the second funnel from aft about reached the water. There were no lights burning then, though they kept alight practically until the last.

Before reaching the perpendicular, when at an angle of 50 or 60 degrees, there was a rumbling sound, which may be attributed to the boilers leaving their beds and crashing down onto or through the bulkheads. She became more perpendicular, and finally absolutely perpendicular, when she went slowly down. After sinking as far as the after part of the boat deck she went down more quickly. The ship disappeared at 2:20 A. M.

Observations

I am advised that the *Titanic* as constructed could not have remained afloat long with such damage as she received. Her bulkheads were spaced to enable her to remain afloat with any two compartments in communication with the sea. She had a sufficient margin of safety with any two of the compartments flooded which were actually damaged. In fact, any three of the four forward compartments could have been flooded by the damage received without sinking the ship to the top of her bulkheads. Even if the four forward compartments had been flooded the water would not have got into any of the compartments abaft of them, though it would have been above the top of some of the forward bulkheads. But the ship, even with these four compartments flooded, would have remained afloat. But she could not remain afloat with the four forward compartments and the forward boiler room (No. 6) also flooded. The flooding of these five compartments alone would have sunk the ship sufficiently deeply to have caused the water to rise above the bulkhead at the after end of the forward boiler room (No. 6) and to flow over into the next boiler room (No. 5), and to fill it up until in turn its after bulkhead would be overwhelmed, and the water would thereby flow over and fill No. 4 boiler room, and so on in succession to the other boiler rooms, till the ship would ultimately fill and sink.

It has been shown that water came into the five forward compartments to a height of about 14 feet above the keel in the first ten minutes. This was at a rate of inflow with which the ship's pumps could not possibly have coped, so that the damage done to these five compartments alone inevitably sealed the doom of the ship.

The damage done in the boiler rooms Nos. 5 and 4 was too slight to have hastened appreciably the sinking of the ship, for it was given in evidence that no considerable amount of water was in either of these compartments for an hour after the collision. The rate at which water came into No. 6 boiler room makes it highly probable that the compartment was filled in not more than hour, after which the flow over the top of the bulkhead between 5 and 6 began, and continued until No. 5 was filled. It was shown that the leak in No. 5 boiler room was only about equal to the flow of a deck hose pipe about 3 inches in diameter. The leak in No. 4, supposing that there was one, was only enough to admit about 3 feet of water in that compartment in one hour and forty minutes. Hence the leaks in Nos. 4 and 5 boiler rooms did not appreciably hasten the sinking of the vessel.

The evidence is very doubtful as to No. 4 being damaged. The pumps were being worked in No. 5 soon after the collision. The 10-inch leather special suction pipe which was carried from aft is more likely to have been carried for use in No. 5 than No. 4, because the doors were ordered to be opened probably soon after the collision when water was known to be coming into No. 5. There is no evidence that the pumps were being worked in No. 4.

The only evidence possibly favorable to the view that the pipe was required for No. 4, and not for No. 5, is that of Scott, a greaser, who says that he saw engineers dragging the suction pipe along one hour after the collision. But even as late as this it may have been wanted for No. 5 only.

The importance of the question of the damage to No. 5 is small, because the ship, as actually constructed, was doomed as soon as the water in No. 6 boiler room, and all compartments forward of it, entered in the quantities it actually did. It is only of importance in dealing with the question of what would have happened to the ship had she been more completely subdivided. It was stated in evidence that if No. 4 had not been damaged, or had only been damaged to an extent within the powers of the pumps to keep under, then, if the bulkheads had been carried to C deck, the ship might have been saved. Further methods of increased subdivision and their effect upon the fate of the ship are discussed later.

Evidence was given showing that after the watertight doors in the engine and boiler rooms had been all closed, except those forward of No. 4 group of boilers, they were opened again, and there is no evidence to show that they were again closed. Though it is probable that the engineers who remained below would have closed these doors as the water rose in the compartments, yet it was not necessary for them to do this, as each door had an automatic closing arrangement, which would have come into operation immediately a small amount of water came through the door. It is probable, however, that the life of the ship would have been lengthened somewhat if these doors had been left open, for the water would have flowed through them to the after part of the ship, and the rate of flow of water into the ship would have been for a time reduced, as the bow might have been kept up a little by the water which flowed aft.

It is thus seen that the efficiency of the automatic arrangements for the closing of the watertight doors, which was questioned during the inquiry, had no important bearing on the question of hastening the sinking of the ship, except that, in the case of the doors not having been closed by the engineers, it might have retarded the sinking of the ship if they had not acted. The engineers would not have prevented the doors from closing unless they had been convinced that the ship was doomed. There is no evidence that they did prevent the doors from closing.

The engineers were applying the pumps when Barrett, leading stoker, left No. 5 boiler room. But even if they had succeeded in getting all the pumps in the ship to work they could not have saved the ship or prolonged her life to any appreciable extent.

Effect of Suggested Additional Subdivision Upon Flotation

Watertight Decks—It is in evidence that advantage might be obtained from the point of view of greater safety in having a watertight deck.

Without entering into the general question of the advantage of watertight decks for all ships, it is desirable to form an opinion in the case of the *Titanic* as to whether making the bulkhead deck watertight would have been an advantage

in the circumstances of the accident, or in case of accident to ships of this class.

I am advised that it is found that with all the compartments certainly known to have been flooded—viz., those forward of No. 4 boiler room—the ship would have remained afloat if the bulkhead deck had been a watertight deck. If, however, No. 4 boiler room had also been flooded, the ship would not have remained afloat unless, in addition to making the bulkhead deck watertight, the transverse bulkhead abaft of No. 4 boiler room had been carried up to D deck.

To make the bulkhead deck effectively watertight for this purpose it would have been necessary to carry watertight trunks round all the openings in the bulkhead deck up to C deck. It has been shown that with the bulkhead abaft No. 5 boiler room carried to C deck the ship would have remained afloat if the compartments certainly known to have been damaged had been flooded.

I do not desire to express an opinion upon the question whether it would have conduced to safety in the case of the *Titanic* if a watertight deck had been fitted below the waterline, as there may be some objections to such a deck. There are many considerations involved, and I think that the matter should be dealt with by the bulkhead committee for ships in general.

Longitudinal Subdivision—The advantages and disadvantages of longitudinal subdivision by means of watertight bunker bulkheads were pointed out in evidence.

While not attempting to deal with this question generally for ships, I am advised that if the *Titanic* had been divided in the longitudinal method, instead of in the transverse method only, she would have been able, if damaged as supposed, to remain afloat, though with a list which could have been corrected by putting water ballast into suitable places.

This subject is one, however, which again involves many considerations, and I think that for ships generally the matter should be referred to the bulkhead committee for their consideration and report.

Extending Double Bottom up the Sides—It was shown in evidence that there would be increased protection in carrying the double bottom higher up the sides than was done in the *Titanic*, and that some of the boiler rooms would probably not then have been flooded, as water could not have entered the ship except in the double bottom. In the case of the *Titanic* I am advised that this would have been an advantage; but it was pointed out in evidence that there are certain disadvantages which in some ships may outweigh the advantages. In view of what has already been said about the possible advantages of longitudinal subdivision, it is unnecessary further to discuss the question of carrying up the double bottom in ships generally. This matter should also be dealt with by the bulkhead committee.

Watertight Doors—With reference to the question of the watertight doors of the ship, there does not appear to have been any appreciable effect upon the sinking of the ship caused by either shutting or not shutting the doors. There does not appear to have been any difficulty in working the watertight doors. They appear to have been shut in good time after the collision. But in other cases of damage in ships constructed like the *Titanic*, it is probable that the efficiency of the closing arrangement of the watertight doors may exert a vital influence on the safety of the ship. It has been represented that in future consideration should be given to the question "as to how far bulkheads should be solid bulkheads, and if there should be watertight doors, how far they may or may not be automatically operated?" This, again, is a question on which it is not necessary here to express any general opinion, for there are conflicting considerations which vary in individual cases. The matter, however, should come under the effective supervision of the Board of Trade much more than its seems to come at present, and should be referred to the bulkhead committee for their consideration, with a view to their suggesting in detail where doors should or should not be allowed, and the type of door which should be adopted in the different parts of ships.

The Graving Dock at Halifax, N. S.

BY E. A. SAUNDERS

Halifax has one of the finest graving docks on the Atlantic seaboard, and it is one which until very recently was also the largest. The dock was commenced in 1879 and was the better part of three years building. When the United States government were obliged to dock the battleship *Indiana*, it was found the Halifax dock was the only suitable one in which to place her, and Admiral Francis T. Bowles, who superintended the repairs, gave the following report:

"The Halifax dry dock is admirably located, in reference to the tidal current, for convenience for safety of vessels in entering and leaving the dock, and reflects much credit on those who planned this feature, so important when large and heavy vessels are to be handled in narrow limits. I have never seen such an altogether desirable arrangement.

"When the *Indiana* was docked, about an hour before high water, the tide gave 26 feet 6 inches over the sill and 28 feet 6 inches over the blocks, as set for that ship. The draft over the sill and length and breadth are ample to admit the largest warships afloat."

The dimensions of the dock are as follows:

	Feet
Length on top	600
Length on top keel blocks	560
Width of dock, coping level	102
Width available top keel blocks	79.2
Width of entrance, coping level	89.3
Width 17.3 feet below coping level	85
Depth of water on sill	30

In this dock the Hamburg-American steamer *Bremen*, 11,570 tons, was easily placed with her cargo and coal on board—a deadweight of 16,500 tons; this steamer with cargo is larger than any in the Canadian Atlantic trade to-day. When the dock was built it was considered sufficiently large to provide for the natural growth of steamers for a number of years, but the transatlantic traffic has grown so great during the past several years that vessels of very much increased size are now being planned, consequently the dock at this point is about to be increased sufficiently in size to accommodate them. In connection with the dock there is a first-class repair plant and several steamers have been practically rebuilt, viz., the *Ulunda, Universe, Knight Bachelor*, H. M. S. *Indefatigable* and others.

The dock is built of concrete and granite in a solid rock location, with spacious piers and deep water berths in connection. It is owned by the Halifax Graving Dock Company, Ltd., of London, and its original cost is said to have been in the neighborhood of $1,900,000 (£390,000); large sums have also been spent on the repair plant, which is a modern one in all respects.

The same company owns and operates a marine slip, situated on the Dartmouth side of the harbor, and used altogether for repairing and metalling ships up to 3,000 tons. In connection with the slip there are, in all, four tracks with six cradles, one with a capacity of 3,000 tons, one of 900 tons, two of 150 tons, and two of 100 tons, and as many as ten vessels have been repaired at once on these different cradles. This slip is also well equipped with a repair plant, which has been renewed from time to time, and is now a modern one in every particular.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Faults in Machinery Arrangements

It is proposed in the following notes to consider certain points in machinery arrangements from the point of view of the operating engineer. The majority of the points dealt with will no doubt appear obvious to the more experienced members of the profession who are in the habit of arranging machinery, but their repetition may be helpful to some of the more junior members.

First let us consider those defects which may cause loss of life or endanger the ship. Perhaps the commonest cause of accident is water-hammer, and steam connections must be carefully arranged to obviate the possibility of its occurrence. To this end steam pipes must never be arranged with dips or pockets in which water may lodge unless these points are efficiently drained, preferably by means of a steam trap. The pipes should have a continuous fall in one direction or another—the ideal arrangement being a fall from the boilers to a separator of ample capacity and a rise from the separator to the main engines. The separator should be fitted with a water gage and a connection from the bottom to a steam trap. A separate drain valve leading to the hot-well or feed tank is an advantage in case the steam trap "jibs," and some traps which depend on the action of a float are rather apt to stick when used on shipboard. Even points where only a very small amount of water may collect must be looked on with deep suspicion, as, when steam is turned on to a pipe line the effect of even the smallest quantity of water is to produce a partial vacuum, thus causing a rush of steam, which will project the water along the pipe with dangerous velocity.

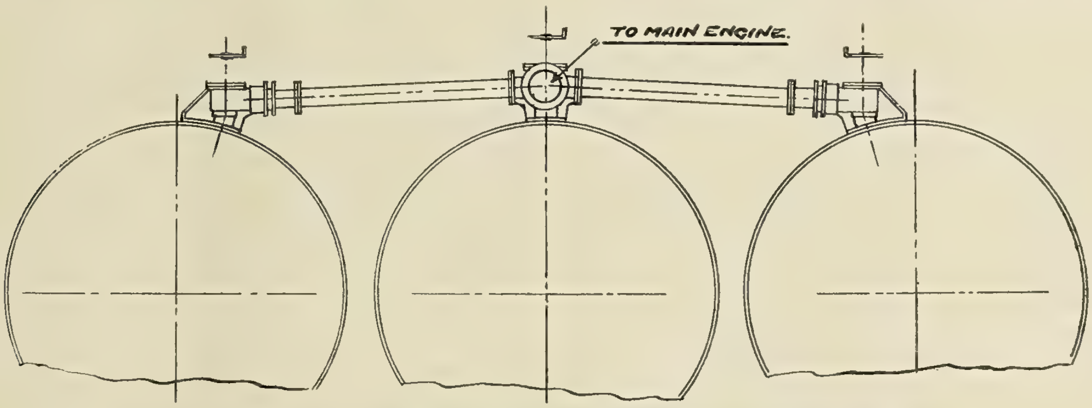
Where it is necessary to adopt an arrangement in which the steam pipes rise from the boilers, drain cocks must be fitted to the boiler stop valve chests above the valves. The lack of drain cocks in an arrangement of this type caused a serious accident in a case within the writer's experience.

The arrangement is indicated in the sketch. It will be seen that there were three boilers abreast, the pipes from the wing boilers rising to a gathering piece which formed the upper part of the stop valve chest of the center boiler, while the pipe to the main engines also rose from this point. The pipes were straight and of wrought iron, and were fitted with expansion joints as indicated, the whole being a very usual arrangement. The ship and machinery were quite new, being still in the builders' hands.

Preparatory to the basin or dock trial, steam was raised in the center boiler for warming-up purposes, and its stop valve opened. The port boiler was then fired up, and when sufficient pressure was showing its stop valve was also opened, and immediately the stop valve on the cold (starboard) boiler was blown to pieces.

The explanation of this is not far to seek. Water had collected over the port boiler stop valve, and when this valve was opened the plug of water was projected with great velocity along the pipe over the center boiler, bringing up against the starboard boiler stop valve, which it smashed to pieces.

Had the stop valve been opened very gradually, as it should have been, no trouble would have happened. In all such cases, however, drain cocks should be provided, and in addition should be so arranged that they can be got at without an acrobatic performance, otherwise it is unlikely they will ever be opened. Where it is possible the handle of the drain cock should be led up alongside that of the valve itself.



THE LACK OF DRAIN-COCKS CAUSED A SERIOUS ACCIDENT IN THIS ARRANGEMENT OF STEAM PIPES

Another common cause of accidents is insufficient provision for expansion in steam pipes where this provision takes the form of bends. There is no doubt that expansion bends, when properly designed, are preferable to expansion joints, but with large pipes these latter are very often a necessary evil. The writer has seen quite a number of jobs where the provision for expansion was so inadequate, the bends being so stiff, that the engineers were running very grave risks. Such cases are usually the work of small, unimportant firms who employ cheap and inexperienced men. Important firms of large experience are usually very particular on this point. The writer remembers being with a famous firm whose manager (a man of world-wide reputation), when shown an arrangement of steam pipes, invariably asked if it were not possible to put in larger or easier bends.

It is scarcely possible to lay down hard-and-fast rules on this subject; each case must be considered on its merits, and a few minutes of experiment with a piece of steel wire will do more to demonstrate the relative "springiness" of various arrangements than many pages of explanation. Try to get the expansion taken up by flexing a long "leg" of pipe, and remember that fine old engineering maxim, which says, "Better be sure than sorry," and don't forget that an inquiry or an inquest isn't good for a firm. See that the necks of valves or casings subject to bending stresses due to pipe

expansion are strong or well ribbed. These stresses are not easily estimated, so it is well to be on the safe side.

It may be added that the necessity of stout, well-ribbed necks applies very forcibly to boiler mountings. The writer is not likely to forget a case where the scum valve broke off in the hands of the engineer who was closing it. Note, also, that the flanges of mountings joining the boiler should be extra good and heavy, while the studs securing these flanges to the boiler shell should not be less than ¾ inch diameter for even the smallest fittings.

Where expansion joints have to be adopted in a steam pipe line, remember that they will only take up expansion in one direction. The writer has seen some instances where one expansion joint was expected to take up a sideway motion in addition to the movement in the proper direction. Now, an expansion joint is usually a nuisance at any time, but under these conditions, with the sleeve and packing pushed to one side, it is bound to be anything but a joy to the engineer. Don't forget to make adequate provision to take up the unbalanced thrust of the expansion joint. This load is equal to the product of the steam pressure and the sleeve area. Where a boiler stop valve forms one end of a steam pipe line fitted with an expansion joint, the stop valve neck should be re-enforced with a good foot. If the unbalanced load is taken up on a bulkhead or other shipwork see that it is amply strengthened to resist it. Unless the pipe joining an expansion joint is very short and rigid, safety stays must be provided to prevent the possibility of its being blown out. It is not only in connection with steam pipes that freedom of movement is essential, for this requirement also applies to most pipe runs.

Although water pipes are not subject to much expansion, due to changes in temperature, where they are connected between bulkheads they are subject to the working of the ship, and must not be too rigid. Again, when connected to pumps or to the main engines the movement from these may in time fatigue a pipe which is too stiff. Of course, in these points judgment must be exercised, for it is evident that a small copper pipe is not under the same conditions as a cast iron one.

Another argument in favor of flexibility in pipe lines (and one which most sea-going men will endorse) is greater ease in making joints.

The necessity for strong necks on boiler mountings has already been emphasized; the same necessity applies also to the necks of sea valves joining the ship's skin, as in both cases a fracture of the neck below the valve would be a very serious matter and one not easily remedied. A case which illustrates this point occurred some years ago. The steamer *U*————, belonging to a well-known line, was in mid-ocean. The second engineer was on watch when he noticed that there appeared to be a considerable amount of water in the bilges. He accordingly put on the bilge pumps, but looking again some time after he was astonished to find that the water had risen considerably. Thinking that the pumps must be at fault he hurried up on deck, only to find that a good solid discharge was coming from the ship's side.

Finding the water to be still rising he started up the ballast pump and opened the special suction valve which puts this pump on to the bilges. Even this made no apparent impression, and being by this time considerably alarmed he called the chief, and when he arrived the floor plates were almost awash. As a last resort the main inlet valve was closed and the bilge-injection opened. This was effectual in lowering the water, when it was found that the neck of the main inlet valve was fractured, being only held in place by the pipe. Shores were obtained and wedged between the valve cover and the deck above, so as to close the opening as nearly as possible. A wooden box was next built around the valve, and filled with concrete made with broken firebrick. This made a good, sound job, which took the ship safely to port.

The mishap which came very near to causing the loss of the vessel (and which might easily explain more than one total disappearance) was probably in this case due to two causes. In the first place the neck of the sea valve might with advantage have been stronger, but probably the second reason advanced may have had a good deal to do with it. The pipe leading from the main inlet valve to the circulating pump (which was driven off the main engines) was dead straight. Again, the engines "worked" considerably, and it has been suggested that this movement, acting at the end of this straight pipe, caused a bending and twisting action on the neck of the inlet valve, which in time so fatigued it as to cause fracture.

Leaving now the consideration of some of the points affecting safety at sea it is proposed to deal with a few items in regard to machinery arrangements from the point of view of the sea-going engineer. A well-known professor of engineering of a North of England university (himself a practical man) used to strongly impress upon his students "the absolute necessity of so arranging machinery as to reduce to a minimum the inevitable profanity on the part of the operating engineer." In order to carry out this laudable object it is essential to consider each item from the point of view of the operating engineer and to enter into his joys and sorrows. This, of course, is only possible to the practical engineer, and no other should be allowed to arrange machinery.

The writer has been connected with several of the foremost marine engineering establishments in Great Britain, and in his experience the draftsmen who are responsible for the design and arrangement of the machinery are usually men who have been brought up with marine engines, who have served an apprenticeship in all the various shops, and who have, in addition, a technical college and often a university training. These men are highly trained specialists and have little to learn from any sea-going man. On the other hand, there are firms who will not pay to secure the services of efficient men, so that their reputations and the unfortunate engineers who have the running of their jobs at sea are bound to suffer.

Judging from letters which have appeared in these columns on the subject of faults in machinery design, there appears to be a certain amount of vagueness with reference to the person to be blamed. Thus one gentleman appeared to consider that the machinery builders should supply steam separators, exhaust steam heaters, grease extractors, etc., purely out of kindness of heart. Evidently he had never heard that marine machinery (in this country, at any rate) is built strictly to specification and in the face of very severe competition. That there were difficulties in the way of this free gift he evidently realized, for he writes, "You will never get it out of the drawing office." It is scarcely likely, unless this expensive auxiliary machinery is either specified or paid for.

As a matter of fact, the people who are primarily to blame are the shipowners themselves. They should employ an experienced superintendent engineer, who is in touch with all the special requirements and conditions which apply to his company's steamers. He should draw up his specification with special reference to these requirements, and see that his ideas, the result of his own experience, are embodied in the actual vessel. Secondly, the shipowners should pay a reasonable price and see that it is a firm with a reputation to lose who carries out the work.

To return to the subject. It is not possible to lay down hard-and-fast instructions in order to secure the ideal of minimum profanity mentioned above, but a few suggestions may be made. It must be remembered that there are other standpoints from which a design must be considered besides that

of the operating engineer, who is seldom in a position to appreciate all the conditions. On the other hand it is usually possible to produce a job which will satisfy all requirements and yet not turn the engineer gray-headed. Probably the most important consideration affecting the operating engineer is accessibility. See that every part that may require attention can be got at with the minimum amount of trouble. Thus in placing the boilers leave sufficient space at the backs for access to the combustion chamber stay ends, while all seams and rivet heads should be so placed, with regard to shipwork, that they can be readily calked. The writer has seen a butt-strap completely covered by an overhanging bunker-side, so that it was quite impossible to get near it.

Again, auxiliary engines should be arranged so that the necessary adjustments and overhauling can be readily carried out. Avoid placing auxiliary machinery too closely into a corner. The writer remembers having to get out the coils of an evaporator which was packed hard up into a corner of the engine room. The nipples securing the coils were behind, and he even yet longs intensely to say a few words to the man who arranged it in that position.

The operating gear for the main engines should be placed so that one man can work everything quite handily. Engines have come under the writer's notice with the reversing wheel on one column, the regulator valve wheel on another, and the throttle and starting levers on the other, while the drain cock handles were all over the place.

A most important point which does not always receive the attention it deserves is the arrangement of ladders and platforms. Ladders and platforms make up a quite inconsiderable fraction of the total cost of machinery, and a little extra attention in this direction means much to the operating engineer. In addition, the means provided for getting about usually impress a visitor to a ship as much as anything else, so that it is to the interests of the machinery builder to give some extra care to these points. See that the engine room entrance ladders have a good, easy rake, not steeper than 1 in 2 if possible, and avoid making the ladders in long lengths without landings.

Good space for overhauling should be provided on the top platform, which should be arranged at a convenient height for working at the cylinder covers. Try to get decent head room on the middle or packing platform, and avoid the necessity of crawling to get at the gear. See that every valve and cock in the ship can be got at in comfort, remembering that contortionist performances in a high temperature are not conducive to good temper. In this respect the stokehold is often somewhat neglected. Arrange the boiler stop valves so that they can be got at easily and quickly, and avoid placing them close under the uptakes. A good deal more attention might be paid to these matters with considerable advantage, for the writer has seen some boiler tops "arranged" so that the manipulation of the valves was a very good preparation for the engineer's future state. An example of how not to do it was the case of a certain vessel, where, in order to get at the gage-glass cocks, the unfortunate engineer had to fix a rope round the stop valve, put a loop in the end of the rope, and with his foot in the loop lower himself over the boiler crown. The writer also remembers as an apprentice helping to drag his mate from the boiler tops of a cross-channel steamer where he had fainted in his efforts to reach a pressure gage cock. It cannot be too strongly urged that careful attention should always be directed to the placing of the mountings on the boiler tops with reference to their accessibility.

See that every pipe joint can be readily got at, and never arrange pipes so that about half a dozen have to be removed to get at one. If a pipe trunk is fitted to take pipes through a cross bunker, see that it is of ample size for a man to get in and remake joints. The writer has come across pipe trunks where the joints could certainly be seen, but to remake them the bunker side would require to be taken out.

Under-floor pipes being out of sight are often neglected as to accessibility. If possible no pipe joint should be covered by another pipe, but every joint should be visible when the floor plates are removed. See that the strainers in the bilges at the suction ends of the bilge pipes are not covered up by pipes, etc., so that the job of clearing them is no worse than it otherwise would be.

In scheming out pipe systems and connections endeavor to make them as simple and fool-proof as possible. Don't arrange matters so that the engineer has to carry out some mental gymnastics to decide which valves are to be opened and which closed. A good deal can be done in this respect to save the engineer trouble. Thus take the case of a pump with several suctions. Don't place a valve here and a change cock somewhere else, but arrange the whole thing in one valve chest at the pump with nameplates to distinguish the suctions.

Again, suppose the auxiliary exhaust system is connected to the auxiliary condenser, to the main condenser and to the atmosphere, it is better to arrange one valve chest to control these and place it in a convenient position where changing over can be rapidly carried out than to have the valve for exhaust to auxiliary condenser in one corner of the engine room, that for the exhaust to atmosphere in another and the valve for exhaust to main condenser somewhere else. Numerous instances might be cited, many of which will doubtless occur to most sea-going men. BRITISHER.

Carels-Westgarth Marine Diesel-Engined Ship Eavestone

On July 22 the writer was present on the trial run of the Diesel-engined ship *Eavestone*, which is a 3,700-ton cargo ship fitted with a 1,000-horsepower, four-cylinder, two-cycle Carels marine engine. We made a start without any difficulty and spent a day on the North Sea maneuvering in every conceivable manner. There was no noise in the engine room, no vibration, no heat radiating from the engine, no smoke from the exhaust. It was very easy to reverse the engine from full speed ahead to full speed astern in eight seconds. We could vary the speed of the engine from its normal 100 revolutions per minute to 40 revolutions per minute in three seconds.

The engine is built on the lines of a marine steam engine. It actuates the scavenging pumps, the circulating water pumps and the bilge pumps from the cross-head by rocker arms. The engine behaved as if it had been in training for years, when, in fact, this was its first day's run, having been assembled in the ship without any testing in the shop of its builders, Messrs. Carels Bros., Ghent, Belgium. H. R. W.

Antwerp.

In Breakdown Time

That in breakdown time the marine engineer has very often to "fight" under adverse conditions is a truth too widely known to be reasserted again. And although it is true also that these conditions are steadily improving in this age of monster ocean liners, wireless telegraph and simplified machinery, yet 95 percent, if not more, of the operating marine engineers have to make repairs "using" more brains than hands, looking at the miserable resources that the limited space of the storeroom in a vessel carries and offers to him.

The following brief stories of breakdowns and their repairs will show better than a well-written article the truth of this statement.

Without a Tube Expander

A continuous trouble in a Scotch marine boiler, 6 feet in diameter and 9 feet long, fitted in a seagoing launch, was a

leakage through the joints connecting the tubes with the fire-box sheet.

The ship was out of commission, but with the machinery ready "to steam," when an order to get up steam as quickly as possible was received to relieve another vessel temporarily at her station; with the urgency of the order a tube expander could not be put on the list for provisional tools, and, furthermore, there were instructions to secure from the ship to be relieved the necessary tools as well as the supplies that might be needed.

After a 24-hour run we arrived at the station and relieved the vessel. It happens then that the tube expander aboard the latter was ¼ inch larger in diameter than that necessary

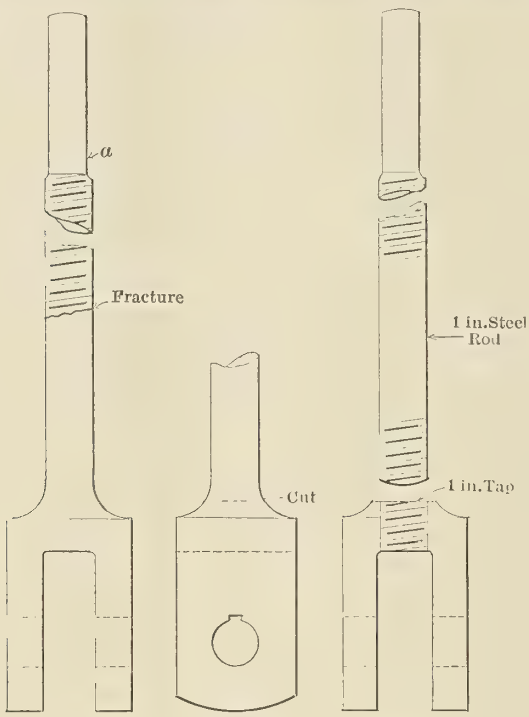


Fig. 1 Fig. 2 Fig. 3

for the relieving vessel, so we had to proceed on our voyage without an expander.

At the ending of the second trip several boiler tubes began to leak so badly that the steam pressure could not be kept at its working point. As soon as we arrived in port and blowed the steam off we found seven tubes leaking at their back ends. No tube expander could be found in the town, so one was asked by telegraph to the main office at Manila. It meant a couple of weeks of inertia, but in order to avoid discontinuance of the regular route on which the launch was running, and after a good deal of thinking, an idea of stopping the leakage temporarily was carried into practice as follows:

From a spare boiler tube several pieces or lengths of ring were cut out, each one measuring ⅝ inch wide (⅛ inch wider than the thickness of the fire-box plates). These rings were split so as to make their external diameter equal to that of the internal diameter of the tubes; one end of every ring was beveled a little so as to place them easily on the center of the mouth of every leaky tube.

Exerting some pressure, the rings were finally pulled inside the leaky tubes in such a way that we could see how the leakage was gradually stopping. Once the ferrules were in place the leakage quite totally disappeared. Of course, this was an emergency repair only, but we continued the route and made two round trips, after which the ferrules were removed and the tubes re-expanded.

As these tubes were somewhat old, and notwithstanding that great care was used in preventing sudden changes of temperature in them, they were frequently leaking. Nineteen months later, and as a result of so much re-expanding, five of the tubes became so thin (about one-third of the original thickness) at their back ends that the tube expander was too small. This gave us a hard time, and we were obliged to resort to the same scheme just described, *i. e.*, the fitting of iron rings or ferrules made from a spare tube, as reinforcement to the weak ends, and after fitted at the same location as before they were re-expanded. The idea proved again to be a good one, as the result was water and steam-tight joints, which lasted till the launch was subjected to a general repair.

Broken High-Pressure Valve Stem

The engine for which the boiler with leaky tubes above mentioned generated steam was of the compound-condensing type. Some four years ago, and while running at full speed ahead, the engine stopped suddenly.

We found the cause to be the high-pressure valve stem broken down in two pieces, the fracture being at the root of the threaded part (Fig. 1). There was not a spare valve stem, and the next port to which we were proceeding was at about a four hours' run. In order to reach it we decided to run with one engine. But a difficulty was met with in that the pumps were connected to the high-pressure wrist pin, and, moreover, the low-pressure valve stem was ⅛ inch larger in diameter than the broken one. Fortunately, the external diameter of both low and high-pressure valve rod bushings was the same, consequently after removing the broken stem and its bushings, the low-pressure valve, piston rings and connecting rod, and securing the piston on the top end of its stroke by means of a piece of wood beneath the cross-head slipper, the low-pressure valve rod, with its bushing, was removed and assembled to the high-pressure valve. Then the low-pressure valve receiver was covered and the hole plugged.

With 80 pounds gage pressure and at 90 revolutions per minute (100 pounds and 140 revolutions were the normal run), the two remaining ports were made; and having no telegraph office in the first port the mishap was wired from the last to the main office.

Wishing to continue the regular run under normal conditions as soon as possible and without waiting for the requested new stem, which might have taken one or two months before its arrival aboard the ship, and after reviewing the resources that the storeroom offered, as the town, like the majority of the Philippine ports, lacked both machine shops and hardware stores, the following idea was carried out:

From a steel octagonal bar of 5/16-inch sides, by filing, we got a round bar 1 inch in diameter; one of the ends to a length of about 6 inches was reduced to ¾ inch diameter to provide for the tail end at the top side (a, Fig. 1); the other end was tapped for about 1⅛ inches with 1-inch threads. From the broken spindle the fork end was sawed off (Fig. 2), and a hole was drilled vertically on the center, which was tapped afterward with a 1-inch tap (Fig. 3). The screwed end of the rod, which was of 1-inch diameter, was heated, screwed down to the fork, and finally riveted under this latter (Fig. 3). As the broken stem was ⅛ inch larger in diameter than the home-made one, we had to fix liners to the bushing and thus adjust it to the rod. Taking into consideration the pressure, this stem with the lined bushings was assembled to the low-pressure valve; and the final result was a satisfactory one, as was shown by a three months' run, after which a general overhauling was made on the machinery and a new stem fixed.

Philippine Islands. Augusto Suzara.

The United States Collier *Jupiter*, of 20,000 tons displacement, which is the largest ship built on the Pacific Coast, was launched Aug. 24 at the Mare Island navy yard. The vessel is noteworthy as the first electrically-driven ship ever constructed.

Review of Important Marine Articles in the Engineering Press

Heavy-Oil Engines.—A review of the second and third of a series of lectures by Captain Sankey before the Society of Arts describing heavy-oil engines. In these lectures the principal points were the consideration of the mechanical details of Diesel engines as compared with steam engines and the minor points of difference among the different makes of oil engines themselves. These last are very small and might be due either to the limited time the engines had been built or that a best type had already been evolved. One interesting point of design referred to was the large range of powers available in engines by the use of a few sizes of cylinders and the combination of these in from one to four or even more lines. The review indicates that the lectures were replete with data and figures on design and operation of these engines, and the original papers are probably a valuable contribution to the literature of the subject. Reference was made to fuels, the wide range of oils available and the composition best suited for use. 2,200 words.—*Engineering,* May 17.

The German Naval Architects.—The summer session of the Schiffbautechnische Gesellschaft was held June 4 to 9. The session was to a large degree under the auspices of the navy and included the witnessing of torpedo boat and other maneuvers and a visit to the Kaiser Wilhelm Canal. Four papers with the following authors and titles were read and discussed: *The Development of Submarine Boats and their Engines,* by Marinebaurat J. Berling, of Kiel; *On the Widening of the Kaiser Wilhelm Canal,* by Herr Regierungs und Baurat H. W. Schultz, of Kiel; *The Development of the Torpedo,* by Capitan zur See S. Michelsen, of Kiel; and *Diesel Motor Building at the Germaniawerst,* by Direktor C. Regenbogen. As a review of a review, this article can only barely mention the subjects of importance for shipbuilders. As to the first the submarine boat was considered in two types, the submersible and the submarine. It was assumed in both cases that the vessel had to be able to run at the surface as well as submerged. Therefore, sufficient reserve buoyancy was required to run safely on the surface and in such a way as to rapidly be reduced for diving. Further, provision had to be made for equalizing the weight and moments in the vessel due to suddenly firing a torpedo or slowly using fuel, water, or stores. All this had been done by carefully chosen reserve buoyancy tanks and aid tanks. Submersibles have more reserve buoyancy, better sea qualities, more comfortable quarters, and are safer in case of accident; on the other hand, the submerged speed of submarines is somewhat greater, being 9½ knots as compared to 9 knots for two ordinary specimens of the two types. The propeller is a compromise due to its wide range of service conditions. It has been proposed to build submersibles to 18 knots speed when on the surface and 11½ knots submerged. Attention was paid to four different types of propelling machinery: (1) electric storage batteries and electric motors and oil engines; (2) steam machinery; (3) steam engines with soda boilers; and (4) compressed air in nickel steel tanks, under water propulsion in this case being effected by oil engines. Examples of these types were described in some detail. The last paper read told the early development of the Diesel motor at the Krupp Germaniawerst. Its author then described a number of late designs, some illustrations of which were shown. The Krupps were pioneers in the development of some features of Diesel engine design and were making rapid pace in placing it in first place for usefulness to the marine engineer. The opinion was expressed that it was only a question of time until oil engines of the largest sizes would be acceptable and demanded by owners. The Krupp Co. has already turned out 69,434 brake horsepower of Diesel engines in 640 cylinders. 9,700 words. In two parts.—*The Engineer,* June 14, 21

The Ice-Breaking Steamer Pjotr Welikij.—A peculiar vessel for ice-breaking was designed and built last winter in Sweden. The dimensions of the boat are: Length over all, 182 feet 1 inch; maximum breadth, 50 feet 10 inches; molded depth, 27 feet 5 inches; draft, 21 feet 4 inches; displacement, 1,900 tons. The lines bear a slight resemblance to a yacht's, and, although of such large ratio of beam to length, on trial she exceeded the required speed of 12½ knots by 2 knots. The propelling machinery of the ship consists of four single-ended Scotch boilers 14 feet 6 inches in diameter and 8 feet long, worked under forced draft. The main engine has cylinders 22 7/16, 35 7/16, and 59 1/16 by 39⅜ inches stroke and a maximum designed horsepower of 2,500. Forward there is located a smaller engine with cylinders 15 15/16, 25⅝ and 41⅜ inches diameter, of 1,200 designed horsepower, driving a smaller screw through a Benn coupling which throws out the propeller automatically if a dangerously large piece of ice be struck. A notable feature of the hull is a number of large ballast and trimming tanks served by powerful pumps, by which the ship can be worked through very thick ice floes. Thorough tests have proven the ship entirely satisfactory. 780 words. Illustrated with photograph and drawings of general arrangement.—*Engineering,* June 7.

Icebergs and Their Location in Navigation.—An editorial review of a lecture upon this subject at the Royal Institution, by Dr. Howard T. Barnes, F. R. S., Professor of Physics at McGill University, Montreal. The ice-fields in the North Atlantic and the formations generally found were described. The particular subject treated was the temperature of sea water and many interesting results were presented. The usual methods of sea water temperature measurement being entirely inadequate, the speaker has devised a recording micro-thermometer which has proven quite satisfactory for the work. This instrument was placed in a survey boat of the Canadian Hydrographic Service and the contact points set for a reading at a depth of five feet. It was noted that upon approaching an iceberg the temperature slowly rose and then suddenly fell. This was found to be the invariable iceberg effect upon the instrument. Approaching land left its own characteristics upon the tape and other changes in subsurface conditions were easily recognized when once known. The lecture covered a field which may soon become very important, as more investigation brings results in lessened dangers to navigation. 1,700 words.—*Engineering,* June 7.

Ferro-Concrete Sludge-Pumping Pontoon; Manchester Ship Canal.—By W. Noble Twelvetrees, M. I. Mech. E. A description of a boat of novel construction for an unusual purpose. The structure is of ferro-concrete throughout, including decks and houses. Although not self-propelled, it contains a steam plant consisting of a Scotch boiler 13 feet 8 inches in diameter and 10 feet 6 inches long, a vertical compound engine, condenser, three centrifugal pumps and three steam windlasses. In the dredging of the Manchester Ship Canal, when the silt can be dumped onto nearby lands, their fertility is improved and a saving in towing charges is effected. This pontoon is to be moored at some point on the canal and the barges towed to it, when the dredged material is pumped out of the barge across the pontoon and onto the land. The article describes in some detail and shows clearly by drawings the construction of the pontoon. It is 100 feet long, 28 feet wide, and 8 feet

6 inches deep to main deck with a load draft of 6 feet 6 inches. It is divided transversely by four watertight bulkheads and longitudinally by two. Each compartment was tested for watertightness. The outer shell is 3 inches thick, except in way of boiler and bunker space, where it is 4 inches. Judged by the results of recent experience with ferro-concrete structures, there is little to fear of the pontoon ever being seriously damaged by collision. The reasons given for the use of this material were the lower first cost, the elimination of maintenance charges, and the readiness with which possible repairs could be effected. 2,000 words.—*Engineering*, June 14.

French Warship Building.—A resumé of the French Naval Programme for 1913, which provides for laying down four battleships, in addition to five to be advanced and two to be completed during the year, making eleven in progress of construction. The last two named are 540 feet in length, and at 29 feet draft displace 23,100 tons, with Parsons turbines of 28,000 shaft horsepower to give a speed of 20 knots. In the five battle ships now in progress, the general dimensions are the same, but 500 tons more displacement is to be allowed at the same draft, and in consequence the Parsons turbines will be 29,250 shaft horsepower to give 20 knots. No cruisers are provided for, and as regards the torpedoboat destroyer programme, nine vessels are to be completed next year, seven of them at private works and two at dockyards, three will be continued and three will be laid down. These are twin-screw turbine-driven ships 265 feet 9 inches in length and 850 tons displacement. Of submarine boats, eight will be completed, ten continued and three will be commenced. The submarines are steadily increasing in size. These later vessels are to be 242 feet 9 inches long and 19 feet 8 inches breadth. Internal-combustion engines of 4,800 horsepower are to be fitted to give a surface speed of 20 knots. Miscellaneous ships included are a submarine mine-laying ship, a transport, and a gunboat. 850 words.—*Engineering*, June 14.

Test of an External-Joint Film Oil Heater at the Engineering Experiment Station, Annapolis.—The object of the test was to determine the rate of heat transmission in British thermal units per square foot of heating surface per hour per degree Fahrenheit temperature difference between the steam and oil for various steam pressures and rates of flow of oil. The size of the inner tube of the heater was 5 inches diameter and 43½ inches length between headers, having a heating surface of 6.13 square feet. The test is reported complete and is accompanied by a drawing of the heater and photographs of the apparatus as set up. The results are plotted as curves. The most economical operation of the system would seem to occur when the steam pressure is reduced until the outlet temperature is not any higher than necessary for the operation of the burners. 4,200 words.—*Journal of the American Society of Naval Engineers*, May.

The Corrosion of Bronze Propeller-Blades.—By William Ramsay, F. I. C. An examination of several specimens of bronze propeller-blade corrosion, which are divided into three or four types, classified by the position on the blades. In a previous study of this subject by the same author, the causes were stated to have been mechanical erosion. Attempts to counteract this action by improved alloys have not been entirely successful. In this study the effects of electrolytic corrosion upon metals under heavy stress are shown to be capable of causing the trouble. This has been shown, among other ways, by a simple experiment upon two bent pieces of sheet metal immersed in sea water and coupled to a delicate galvanometer. A strain upon one increases its electromotive force, the increase being greater if the stresses were vibratory. Immersed in an electrolyte an electric current will flow between the two parts, the strained metal being attacked or dissolved, while the unstrained metal is comparatively unaffected. In the latest type high-speed turbine propellers, these injurious conditions are very much intensified, and in conjunction with the thinning away of the blade sections, soon makes corrosion dangerous, as has several times actually occurred. The remedy is mainly one of design. Although the metallurgist may improve matters a little, the principal correction is increased blade sections and weight of hubs and wheels as a whole. 3,400 words. Well illustrated.—*Engineering*, May 24.

Converted into Oil-Burners.—The passenger steamers *Prince Rupert* and *Prince George*, of the Grand Trunk Pacific Steamship Co., have been converted to oil-burners. The work has been done at the yards of the British Columbia Marine Railways Co., Esquimalt, B. C., under the supervision of Capt. C. H. Nicholson, manager of the Grand Trunk Pacific Steamship Co. fleet. Owing to the exceptionally large fresh water supply required by these ships, the double bottom tanks are used for its storage and so oil fuel was stored in tanks built in the usual bunker space. Ample fuel space has been installed for a steaming radius of 1,700 nautical miles at 18 knots. The oil-burning system adopted was the Dahl, manufactured by the Union Iron Works of San Francisco. The line has provided a storage tank at Vancouver with a capacity of 32,000 barrels, with a measuring tank of 1,000 barrels capacity and a pumping plant of over 1,000 barrels an hour. Diagram drawings of general arrangements of ships as changed. 2,200 words.—*The Marine Review*, June.

Auxiliary Machinery for Internal Combustion Engined Vessels.—By W. R. Cummins. Second only to the question of the practicability of the Diesel engine itself is that of the auxiliaries for such vessels. The aim of this paper is to show how every auxiliary on board ship, and including steering engine and winches, might be satisfactorily worked without the auxiliary steam line usual in steam-propelled vessels. Each individual auxiliary is taken separately and the solution worked out. Later the whole system is taken as a whole and the advantages inherent in electric, compressed air, and hydraulic power are compared. The electrical solution is said to be entirely practicable; a few good things are said for compressed air, but the efficiency generally is lower than with the electricity, while little was said to justify the adoption of hydraulic system. The paper was followed by a lengthy discussion. In all, 20,000 words. Illustrated.—*Transactions Institute Marine Engineers*, April.

The Brown-Curtis Turbine.—H. M. S. *Southampton*, the latest of the Town class of cruisers, was launched on May 16 from the Clydebank works of Messrs. John Brown & Co., Ltd. This vessel is the third of the class to have Brown-Curtis turbines which have proven very satisfactory both on trial and in service. So favorably is this type considered that the Admiralty accepted the proposal to use it in the latest battle-cruiser *Tiger* recently placed with the same firm. This vessel is to be 698 feet long, 90 feet 6 inches beam, and will displace 28,000 tons. The speed is to be 28 knots, which will require 80,000 indicated horsepower.—*Engineering*, May 24.

The Sperry Gyro-Compass.—An extensive description of the mechanism of this complicated instrument. Fully illustrated by detail and assembly drawings and photographs. Its purpose is to provide the necessity of a true compass by mechanical means, this being done through the gyroscopic action of a wheel rotated in a vacuum by an electric motor, and so supported as to be serviceable under any conditions incident to navigation, and so mounted as to be readily used in a binnacle very similar to the usual form. The instrument is manufactured by the Sperry Gyroscope Co., of New York, and has already been installed on several United States warships. 4,200 words.—*Engineering*, May 31.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

Many of the recent proposals for the development of shipbuilding in both the United States and Great Britain designed to take advantage of traffic through the Panama Canal have been held up awaiting the final action of the present session of Congress regarding the Panama Canal tolls. Without advance knowledge as to the exact conditions under which traffic through the canal would be conducted, it has been impossible to go forward with any preparations for such traffic, but now that this important measure has become a law there is no necessity for further delay in the progress of such plans as are feasible under the existing conditions. In signing the Panama Canal bill as finally modified by the Senate and House, President Taft expresses a very favorable opinion of the measure, stating that the bill is admirably drawn for the purpose of securing the proper maintenance, operation and control of the canal and the government of the Canal Zone and for the furnishing to all patrons of the canal, through the government, of the requisite docking facilities and the supply of coal and other shipping necessities. The features of the bill to which objection has already been made and which may be the subject of further legislation are those relating to the discrimination in favor of the coastwise trade of the United States, the clause prohibiting railroad-owned ships from passing through the canal and the amendment that bars out trust-owned ships. As there is a considerable interval, however, before the canal is finally open for traffic it is probable that any features in this preliminary legislation which prove undesirable for the best interests of commerce will be modified to meet specifically the existing conditions. On the whole, the enactment of this bill should prove a decided stimulus to the industry of shipbuilding.

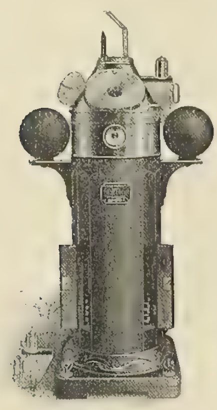
While conditions on the Great Lakes are quite different from those in ocean shipping on account of the continual movement of vast quantities of a specific bulk cargo, such as ore or coal, over certain routes, yet the development of special types of vessels for this traffic has brought out some original features of ship construction that may eventually prove useful in a modified form for adoption in sea-going vessels, especially in bulk freighters. A notable example of the modern bulk freighter is given this month in the description of the new vessels built by the Great Lakes Engineering Works for the Shenango Steamship & Transportation Company. These vessels, while the largest of their type in the world, are designed for only a moderate speed, and consequently require only a comparatively small power for propulsion. But notwithstanding the small machinery weight necessary for this power, no refinement of design is sacrificed which would increase the efficiency of propulsion or lower the fuel consumption. The hull itself is a splendid example of the latest type of bulk freighters, with the hold extending in an unbroken sweep forward from the machinery space, divided only by two screen bulkheads of the box girder construction, the entire deck being given up to hatches. The distinctive feature of this type of hull is the massive arch girder construction, with the hopper sides of the hold carried throughout in a prolonged slope to about one-half the depth of the hold, the lower half having vertical sides terminating on the deep double bottom, confining the cargo within reach of self-filling buckets, thus eliminating hand labor in unloading the cargo. This type of vessel, with its complement of freight-handling appliances, is a distinct American engineering achievement in marine transportation which, as a whole, has resulted in reducing the cost of transportation to a lower figure than anywhere else in the world.

It would seem reasonable to expect that after many years of development in shipbuilding the modern steamship would be almost faultless as far as the arrangement of machinery is concerned, but judging from the experiences of many practical marine engineers there is usually room for improvement in this direction. We think the practical engineer is the man to be heard from on this score, and will gladly welcome criticisms from the engine room for publication, so that a better understanding may result between the shipyard draftsman and the sea-going engineer.

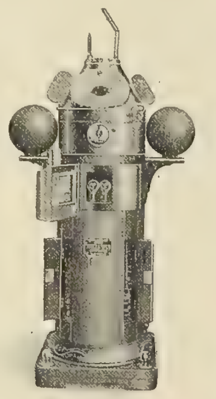
Improved Engineering Specialties for the Marine Field

Hezzanith Mark I. and Mark II. Binnacles

The binnacles, "Hezzanith Mark I. and Mark II.," illustrated on this page, which are manufactured by Messrs. Heath & Company, Ltd., Crayford, London, E. C., embody many useful improvements. The stands, made of the best specially selected hard teakwood, are well calculated to resist the ravages of weather and temperature. The brass work is all tested for absence of magnetic material and the corrector spheres and Flinders bar are tested carefully after being demagnetized. Special attention has been given to the suspension of the compass, resulting in the present arrangement of spring suspension, which is calculated to meet the various vibratory conditions of different ships. The main suspension consists of two beam helical springs (one right-handed and one left-handed), from the ends of which is suspended a saddle piece and hanger which connects with the journal on the compass gimbal. Above these two springs is fitted a laminated bowed-blade damper spring, the function of which is to damp the superfluous vibrations of the helical springs.



"MARK I"



"MARK II"

The pressure exerted by this "damper" on the helical springs is adjustable, and can be varied from nothing at all to producing a condition approximating rigidity. This damping arrangement, which is protected by patents, is claimed to be a most practical improvement and a great factor in producing the stability in the compass card, which is so essential. The whole of this suspension is adjustable in azimuth for about 6 degrees, thus enabling the lubber line of the compass to be set absolutely on the keel-line of the ship.

Another interesting and very practical departure is the method of attaching the binnacle top to the rim. The old way was to fit lugs on the rim and then cut corresponding gaps in the beading of the top. This had two main defects: First, the cutting away of the beading weakened the top, and, second, there was always a lot of "fiddling about" with the top until the gaps were in the correct position to pass over the lugs. In the "Hezzanith" binnacles the top is provided with automatic catches and can be placed securely on the rim in any position. There are no lugs on the rim and no gaps in the beading of the top, and the rim itself consists of a strong, grooved casting instead of the usual beaded and wired sheet brass. To remove the top all that is required is the pressure of the thumbs on two plungers suitably placed close to the handles with which the top is provided.

As is well known, the Mark I. binnacle is provided with oil lamps above the compass; these are removable, and the glazed openings over which they are attached to the top are provided with brass shutters; the lamps can be attached without the shutters being removed, and thus there is no fear of loss of parts. In the Mark II. binnacle the lighting is effected by oil and electric lamps placed below the compass, the compass being transparent to enable the card to be properly illuminated. In these binnacles the oil lamp, which is a new model with two powerful burners, is attached to the binnacle by a very simple and neat device, and can either be left on the binnacle when using the electric light, or, if desired, can be removed, in which case a brass panel slides over the lamp opening. The electric light is provided with a special reducing switch, very useful in taking azimuth observations.

The compasses in both models are provided with suitable viscous fluid chambers, which it is claimed effectively damp all excessive oscillations. The light cards are of specially registered design and give excellent results. If desired, liquid compasses can be fitted to these binnacles, in which case the cards are of small diameter compared with the bowl and have short needles for the purpose of correct compensation. A large magnifier is attached to the compass, which doubles the apparent size of the card. The azimuth instruments and sighting devices are all of improved form, ensuring great accuracy.

A modification of the Mark II. binnacle is the Mark II. "Torpedo" binnacle with an 8-inch liquid compass, which is extra strong and has special arrangements for reducing the light as desired and shutting off all stray beams. A spotting lamp fitted to the top focuses a single beam of light on the lubber line; it can thus be illuminated both above and below with both oil and electric lamps.

Cumberland Electrolytic Process

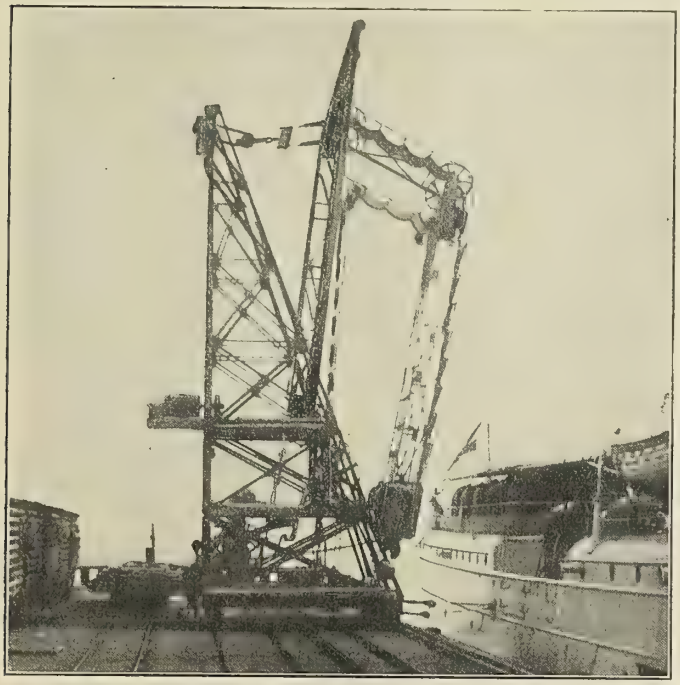
The Submarine Signal Company, Boston, Mass., has secured the right to manufacture and install throughout the United States the Cumberland Electrolytic Process, which is a system for the protection of metals from corrosion, pitting, grooving and formation of scale in steam boilers, feed-water heaters, surface condensers, tanks, etc.

This process is claimed to be a natural, permanent remedy of such troubles. It is a method of electrically protecting metallic bodies wherever oxidization may take place. As oxygen is the destructive agent the Cumberland Electrolytic Process produces hydrogen on the body to be protected. This is done by the following means. An electrode of the positive sign is placed near the body affected, and a determined amount of current from the positive electrode is passed through the medium surrounding the affected body to it. As the positive electrode is destroyed it attracts the destructive oxygen gas or acids and hydrogen gas forms on the body to be protected. The amount of electricity required is extremely small and can be regulated at will, and an instrument is provided showing the amount of energy consumed and that the metallic body is at all times protected.

Handling Bananas Mechanically

A unique mechanical appliance for loading bananas on board ship has been patented by Mr. George Edelston, of New Orleans, La. This machine travels on a trackway alongside the wharf, moving to any position alongside the vessel. The tower stands 45 feet from the wharf level, the main boom extending 35 feet. The main leg, which extends into the ship, measures 28 feet between centers, and by aid of the main, or what is termed the auxiliary boom, may be placed at a convenient distance from the wharf to any position in the hold of the vessel.

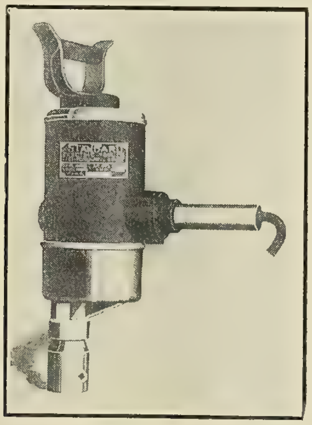
The machine is equipped with a Jeffrey conveyor, manufactured by the Jeffrey Manufacturing Company, Columbus, Ohio, consisting of double strands of Vulcan chain-carrying pockets 48 inches wide. The machine is equipped with a 10-horsepower motor for operating the booms and propelling the truck along the trackway. This same motor also operates the conveyor, although the conveyor itself does not require



more than 2 horsepower for its operation while at normal speed carrying forty-two bunches of bananas per minute. With the use of this machine the delay and drudgery by human labor are reduced, as well as the cost of loading and unloading cargoes. Vessels are now got out of the way in less than half the time than when the bananas were handled entirely by human efforts and passed into and out of the ship's hold from man to man.

High Power Electric Tools

The Standard Electric Tool Company, Cincinnati, Ohio, has developed, and is now placing on the market a line of high-



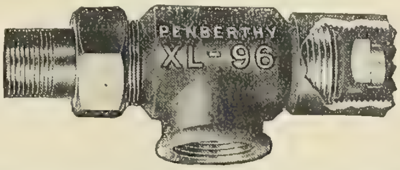
power electric tools, including ball-bearing portable drills and grinders.

In the drills all gears are generated from chrome-nickel steel, case hardened, and are mounted on ball bearings packed in grease, which are claimed to be dust proof. The very highest grade German bearings are used. The motors carry a very strong series winding, which gives them an excess of power over rated capacity, preventing overloads and burn-outs. The drills are built in ⅜-inch and ½-inch sizes for direct and alternating current. The ½-inch direct-current drill is guaranteed to ream up to 7/16 inch in thick metal. In addition a Universal drill of ⅜-inch capacity that will operate on both direct and alternating-current is made. These drills are built and recommended for the most rigorous and hardest constant service. All armatures and poles in both drills and grinders are built up of the best soft electrical sheet steel and are uniformly insulated.

The grinders are made for tool post, bench and parallel work. A special feature in connection with the tool post or center grinder is a base which converts it into a bench grinder by removing a slide and placing the motor in a groove in the top of the base, as this doubles the range of work, increasing the value of the tool in all shops, because while tool-post grinders are indispensable they are used only at intervals, and by this combination they can be kept in constant service. All motors in both drills and grinders are force-ventilated by fans of special design. The grinders are furnished with phosphor bronze bearings adjustable to wear.

An Automatic Ejector

The ejector illustrated is adapted to locations unhandy of access, as in the holds of vessels and other out-of-the-way places. It may be placed under the flooring alongside the keelson or in other parts of a boat where leakage is constant or intermittent. The ejector can be relied upon to start automatically when water rises beyond permissible depths. It will work when operated with either steam or water pressure, and because of this feature it may be placed any distance from the boilers, even so far that steam will condense before



reaching it, as it will work with hot condensation, or it may be located any distance from a steam pump and be worked with water discharged by the sump. When operated with 40 pounds pressure (either steam or water) it will elevate 20 feet, and when operated with higher pressure it will elevate to proportionately greater heights.

This ejector is attached to a valve and float with levers that automatically raise the spindle of the valve when leakage of water buoys up the float and lowers the spindle, closing the valve after the ejector has emptied the leakage. The valve disk is shaped so as to control the pressure that is to operate the ejector, and is made with a diameter of valve opening exactly proportionate to the length or purchase of operating levers and the surface area of the float. This arrangement allows the device to operate automatically throughout a variable range of pressure, without the use of weights or toggles that require adjustment to different pressures.

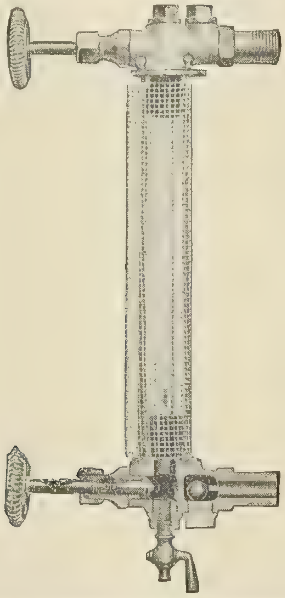
The device is manufactured by the Penberthy Injector Company, of Detroit, Mich.

Watertown Automatic Safety Water Gage

The Watertown automatic safety water gage, which is manufactured by the Watertown Specialty Company, Watertown, N. Y., is a device which it is claimed is absolutely automatic in its action in affording a positive protection from injury due to flying glass and scalding by steam and water when a water gage is broken. Between the shut-off valves and steam and water passages is a chamber containing a hard, accurately ground, bronze, non-corrosive ball, which, together with its seat, constitutes the automatic feature of the safety

device. When in operation the pressure on either side of the ball chamber is equal, so that there is no force tending to hold the ball to its seat. It then falls away from the seat and lies at the bottom of the chamber, leaving the steam and water passages to the glass entirely free.

Should the glass be broken the pressure outside the valves is released and both valves are immediately raised to their seats by the internal pressure, so that the rush of steam and water through the broken glass is positively checked. After the glass is replaced and the drain cock closed, the balls will automatically release and open the gage, as the ball seat is provided with a small grove or by-pass, which allows a slight leakage of steam and water to pass it, so that the pressure on both sides of the ball is soon equalized, and they then fall from their seats, leaving the gage in its regular operating condition.



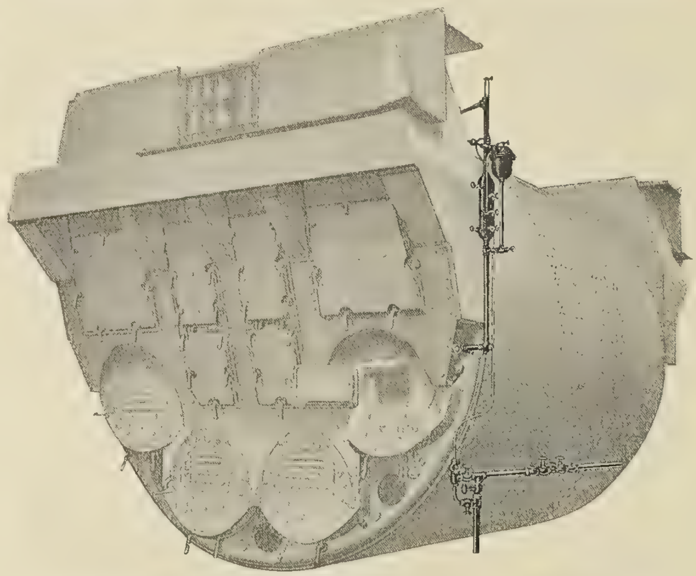
It is claimed that the ball valves cannot stick and partially close the passage, as the ball is held above the bottom of the chamber and against the valve seat by the boiler pressure, and as soon as this pressure is equalized on both sides the ball is forced by the action of gravity away from the seat, which it cannot reach again execpt by being raised by a strong pressure of steam.

Being simple in construction, it is a very easy matter to keep the gage in repair, and aside from occasionally cleaning the gage requires no attention.

The Vigilant Marine Feed-Water Regulator

The Vigilant Feed Water Regulator, manufactured by the Chaplin-Fulton Manufacturing Company, Pittsburg, Pa., is an apparatus designed to regulate the water level in boilers of every description. By its action it is claimed that the water level is held constantly at one point with less than ¼ inch variation, introducing the feed-water in exactly the same quantity as the steam is evaporated. It is of simple construction, so that it cannot easily get out of order, and any one who is competent to operate a boiler can easily understand its operation. The manufacturers claim that it will furnish dry steam to the engines on account of the regulation of the feed pumps, in accordance with the load on the boilers. Also, that it increases the efficiency of the heaters and economizers, maintaining a uniform temperature in the boilers, thus preventing excessive strains from contraction and expansion, and resultant leakage or the burning of fusible plugs. There are no floats or concealed parts to obscure steam passages in the apparatus, but the whole device stands in plain view and can be examined at any time without disturbing the boiler. Should any accident occur to the regulator the change to hand regulation can be accomplished in less than a minute.

The apparatus consists of three essential parts. The first is a special combination union angle valve, which must be inserted in the boiler at the point where it is desired to maintain the water level. The opening in the end of the threaded nipple, having a ½-inch pipe, is half-round, with the top horizontal, and it is the alternate submersion and uncovering of this opening that causes the machine to operate. The second part of the apparatus is a hooded chamber, in which, and to which, is attached the operating mechanism of the regulator. Inside the chamber is suspended a displacement, hung from the end of a lever, which engages with a horizontal shaft. To the protruding end of the shaft is keyed an exterior lever carrying an adjustable cast iron counterweight. This counterweight is of such size that it weighs less than the displacement but more than the displacement when the latter is submerged. The controlling valve is the third part of the regulator, and is placed in the feed line of the boiler, usually in a by-pass, so that it can be cut out at will. In construction it is similar to a check valve.



When the water level in the column is below the opening of the special nipple, the difference in pressure on the valves of the apparatus, as controlled by the weights and steam pressure, will open the controlling valve and admit water to the boiler. When the boiler fills up to the opening of the special nipple, the stem will be sealed by the rising water, the controlling valve closed and the feed-water shut off. No more water can enter the boiler until the water falls to the opening of the special nipple. When steam is admitted to the top of the chamber the water in it falls to the old level, all the operations are reversed, and the controlling valve opens again. The operations are repeated as the water gets above or below the desired point.

Piston Rod for a 5,000 Horsepower Gas Engine, Type "A," Chrome Vanadium Steel, Heat Treated

A hollow-bore piston rod of special material was recently made by the Erie Forge Company, Erie, Pa., for a 5,000-horsepower gas engine. This rod was made of type "A" chrome vanadium steel, heat treated, and the results obtained are shown in the following table, where they are compared with the results required in the specifications:

	Results Required	Results Obtained
Carbon	.30-.35 percent	.30 percent
Chromium	1.00 percent	1.12 percent
Manganese	.46-.60 percent	.59 percent
Silicon	.12-.16 percent	.113 percent
Vanadium	.18 percent	.21 percent
Sulphur	.025 percent	.021 percent
Phosphorus	.020 percent	.012 percent
Tensile strength	110,000-130,000 lbs.	137,500 lbs.
Elastic limit	85,000-110,000 lbs.	108,000 lbs.
Elongation in 2 inches	15-25 percent	18 percent
Reduction of area	40-50 percent	46.3 percent

Technical Publications

A bibliography of all books in the English language on engineering and metallurgy published during the five years 1907-11 is announced for publication by Messrs. Grafton & Company, of 69 Great Russell street, Bloomsbury, W. C. The work has been compiled by Mr. R. A. Peddie, the librarian of the Technical Library of the St. Bride Foundation, and is arranged in alphabetical order of subjects. It will be as useful in America as in England, as both English and American publishers and prices are given. The book will be issued at $2.00 (7/6) net.

The Shipbuilder Press, Newcastle-on-Tyne, have just issued the first of their special annual international numbers (2s. 4d., post free, or 4s. 6d. in cloth), which takes the form of a world's survey of the scientific and technical progress in naval architecture and marine engineering during the past year. This is the first attempt to embody in one volume concise and comprehensive data regarding the latest practice and the results of research, investigations and experiments in every country where shipbuilding is carried on. The work contains a resumé of all the papers—nearly eighty in number—of interest to shipbuilders and marine engineers communicated to the scientific institutions of Great Britain, Germany, France, Italy, the United States, Japan, etc. The various abstracts have been so classified and edited as to afford the most convenient reference, no matter from what country received, while an elaborate index greatly enhances the value of the book. Printed in high-class style on art paper, and containing 200 pages and nearly 250 diagrams, the international number of *The Shipbuilder* should prove of great value to all who are concerned with the technical phases of the shipbuilding and marine engineering industry, and particularly to those British readers who are unable to study in the original the papers presented to the German, French, Italian and Japanese societies, which, as contributions to the literature of the industry, are yearly becoming more valuable.

Diesel Engines for Land and Marine Work. By A. P. Chalkley. Size, 5½ by 8½ inches. Pages, 226. Illustrations, 80. London, 1912: Constable & Company, Ltd. Price, 8/6 net.

This is practically the first book which has been devoted entirely to the subject of Diesel engines. The remarkable development of the Diesel motor in the past two years, however, makes it a very welcome addition to current engineering literature. The general principles of the Diesel engine have been stated briefly in almost every text-book on thermodynamics and heat engines in recent years, but very little information has been available regarding the mechanical features of the Diesel engine; in fact, these have changed so rapidly and have been developed in so many different ways for different purposes, both on shore and afloat, that a comprehensive description of modern Diesel engines could be made only by the compilation of a vast amount of data from many sources. In the present volume, however, this work has been thoroughly done, and there is hardly any successful type of Diesel engine which is not fully described in the book. The first few chapters take up the general theory of heat engines with special reference to Diesel engines and the action and working of the Diesel engine. Following this the reader's attention is turned to the actual construction, installation and running of Diesel engines, and also some data from tests of Diesel engines are given. The final chapters discuss the marine Diesel engine, and are profusely illustrated with photographs and line drawings of the principal marine installations. A very attractive future for this type of engine is suggested, and with the optimistic introduction, written by Rudolf Diesel, the inventor of the engine, the reader will be induced to make a careful study of the contents of the book.

Efficiency as a Basis for Operation and Wages. Third Edition. By Harrington Emerson. Size, 5 by 7¼ inches. Pages, 254. New York, 1912: *The Engineering Magazine.* Price, $2.00.

The fundamental principles of Mr. Emerson's interpretation of efficiency, as applied to industrial affairs, have been before the public for several years, but before the third edition of his work on this subject was published he made a thorough revision of the text, elucidating points upon which experience had shown added emphasis must be laid, adding sections to cover the development of thought and practice since the first draft was written, and establishing points of connection between this volume and the one shortly to follow on "The Twelve Principles of Efficiency." The principal changes will be found in the chapters on "Line and Staff Organization in Industrial Concerns," "Standards" and "The Modern Theory of Cost Accounting."

Heat and Thermodynamics. By F. H. Hartmann. Size, 6 by 9 inches. Pages, 346. Illustrations, 72. New York, 1911: McGraw-Hill Book Company. Price, $3.00 net.

Most books on thermodynamics, and there are many, are written by teachers to meet the needs of the particular class of students under their tutelage. For this reason the subject has been treated in a variety of ways, each of which detracts in no way from the value of the others, but which adds rather to the sum total of available information on the subject. In this case the author distinctly points out in the preface of the book that he had no expectation that his treatise would supersede the admirable standard works on this subject, but that it should serve rather as a proper preparation for the reading of such works. It differs from the others, however, in that the first part of the book is given over to a comprehensive discussion of the fundamental principles of heat measurements, information without which the student cannot make much headway in the study of thermodynamics, and which cannot be obtained easily from lengthy text books on physics or heat. With such a helpful start as can be gained from the study of this valuable part of the book many of the difficulties of the student have been overcome and the subject of thermodynamics can be approached much more readily.

The New Navy of the United States. By N. L. Stebbins. Size, 9 by 7 inches. Pages, 160. Illustrations, over 200. New York, 1912: Outing Publishing Company. Price—cloth bound, $1.50; morocco binding, $2.00.

This book is really a collection of pictures of what is called by the author "Our New Navy." The pictures are supplemented by sufficient descriptive matter to give the reader a good idea of the main details of the vessels illustrated. Most of the pictures are reproductions of photographs made by the author himself, many being the official photographs made at the trials of the ships. The excellent work of the author as a marine photographer is well known to readers of International Marine Engineering from the numerous examples of his work which have appeared in this journal during the last decade. In this book, however, the photographs are reproduced on a larger scale on a fine quality of paper, which adds much to their pictorial value. It has been impossible to procure photographs of all the vessels of the navy, and so the aim has been to show representative types. The data accompanying the pictures have been compiled from official publications and carefully revised and corrected by competent authorities, so that the author's hope that the volume will prove not only of interest to the general public but also as a reliable book of reference by those immediately interested in naval affairs seems well justified. A patriotic introduction is contributed by Admiral George Dewey, admiral of the United States navy, and an interesting article describing the scope of the Revenue Cutter Service is contributed by Capt. Preston H. Uberroth, R. C. S.

Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,022,432. MECHANISM FOR PREPARING BOATS FOR LAUNCHING. JOHN McGOLDRICK, OF BALTIMORE, MD.

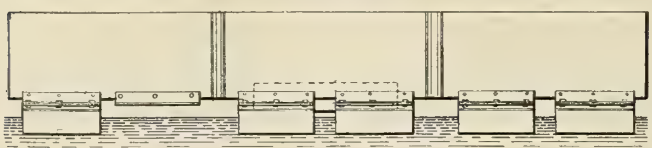
Claim 1.—In a boat-releasing device, the combination with a boat and its cover, and chocks for the boat, of means for securing the boat and cover together, gripes for holding the boat upon the chocks and controlling the position of the said chocks and means for simultaneously releasing the boat from the cover and from the gripes whereby the chocks are also released. Seven claims.

1,022,486. HEATER FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 1. In a torpedo, a containing vessel divided by a partition into water and fuel compartments, a source of compressed air, and means for conducting compressed air under equal pressures into both compartments. Ten claims.

1,022,931. FLOATING DRY-DOCK. ANDREW C. CUNNINGHAM, OF WASHINGTON, DISTRICT OF COLUMBIA.

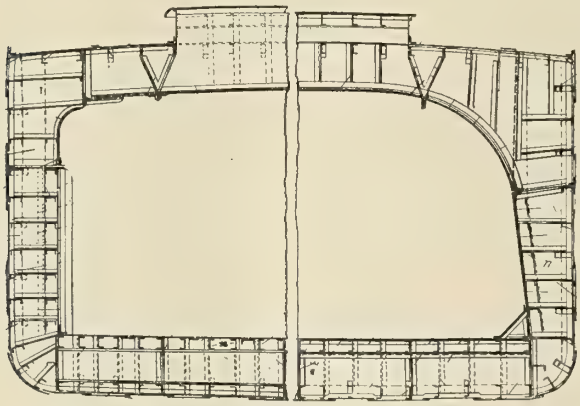
Claim 1.—In a floating dry-dock, a plurality of sections comprising pairs of parallel upright side walls connected end to end in detachable



relation with each other, and a plurality of transverse pontoons underlying and supporting each pair of side walls, said pontoons being interchangeable with respect to the several pairs of side walls. Six claims.

1,020,365. SHIP CONSTRUCTION. JOSEPH R. OLDHAM, OF CLEVELAND, OHIO.

Claim 1.—In a ship or vessel construction, transverse web plates having perforations near their outer margins, longitudinal frames or girders, notched at intervals adapted to be inserted in the perforations of the web plates, the uncut outer margins of the web plates and bars seated in



the notches of the longitudinal frames, the edges of said frames or girders being brought to a position in contact with the shell or deck plating, or flush with the edges of the web plates; filling bars inserted in the perforations abreast of the notches in the longitudinal frames or girders, transverse angle bars and bracket plates for securing said parts together. Ten claims.

1,023,907. MECHANICAL AIR DEVICE FOR EXPELLING WATER OR OTHER LIQUIDS FROM THE HEADS OF TORPEDOES TO AID IN THE RECOVERY THEREOF AFTER FIRING. KENNETH WHITING AND JAMES B. HOWELL, OF THE UNITED STATES NAVY.

Claim 1.—In an automobile torpedo provided with a head, the combination of an air flask located in said head and provided with a passage discharging in said head; a valve controlling said passage; a trigger lever controlling said valve; means controlling said trigger lever to retain said valve closed; additional means adapted to be actuated by pressure due to submergence for releasing said first mentioned means; and a discharge valve in said head adapted to permit water to escape therefrom. Six claims.

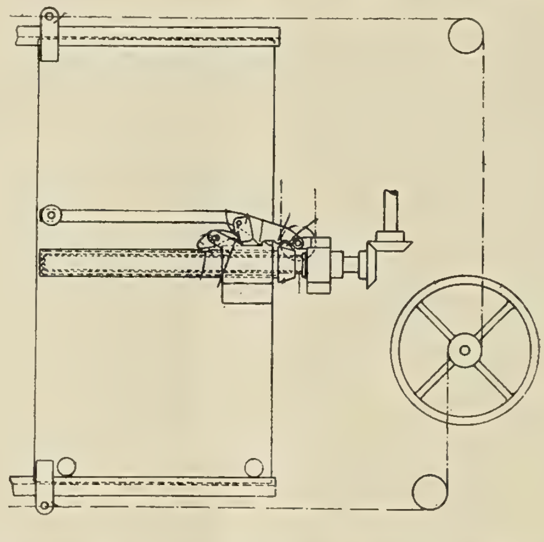
1,024,664. SUCTION TUBE FOR HYDRAULIC DREDGING-MACHINES. LOUIS J. BALTZ, OF BUFFALO, N. Y.

Claim 1.—In an apparatus the combination of a suction tube restricted at one point, a pivoted crusher-jaw wholly confined within said tube and arranged adjacent said destricted point, and means for oscillating said crusher-jaw. Seven claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

28,938. MECHANISM FOR OPENING AND CLOSING WATERTIGHT DOORS FOR SHIPS' BULKHEADS OR THE LIKE. C. KLOCK, OF SCHAARSTEINWEGSBRUECKE, 2, WELSERHAUS, HAMBURG, GERMANY.

Claim.—By this invention the means of suspension are simplified and springs and other unavoidable mechanism eliminated. The improvements may be also applied to horizontally sliding doors. This door may be closed by raising a lever, by turning a spindle, or by manipulating a rope from any part of the ship. In any case the door is dropped on raising the lever. If the screw be turned to move the nut downward the lug presses the nose and throws up the lever, so disengaging the catch on the door, which can then fall. The nut has a long square-



sleeve extension, which still engages the door and prevents the turning of the nut at its lower end, and the screw is rotated until the nut presses the door home. It will be seen that the pin is now to the left of the lever-arm, so that when the nut descends the latch can engage the notch of the sleeve, and on turning the screw in the opposite direction the door is raised until the lever is moved outward by the projection so that the pin and pawl move into the position shown, in readiness for an emergency.

11,404. DEVICES FOR PREVENTING THE STRANDING OR COLLISION OF VESSELS. G. BONIFACIO, KRAUS, BERLIN, AND F. KREIGBAUM, DUSSELDORF.

Claim.—By this invention a pilotboat is driven and steered electrically from the ship and provided with contact devices which, upon striking an obstacle, electrically transmits signals to the ship. An auxiliary device indicates any deviation of the boat from the course and preferably steers it. The pilotboat has a bent lever and a grapnel suspended from it, which serve to catch submerged objects, such as ropes of other vessels having like safety devices, and by closing a circuit they operate signaling, stopping or reversing devices. The boat also has a sounding device suspended from a drag-rope and having feelers which, upon striking the bottom, close a circuit to operate the signaling, etc., device. This sounder is enclosed by an elastic cover to prevent intrusion of sand, mud, etc. The sides of the boat also have feelers with flaps which protect them and allow them to be actuated without directly touching an obstacle. The motion of two steering electro-motors is transmitted to the rudder by gears engaging a common toothed segment connected by ropes with the rudder, each motor moving the rudder in one direction only. The rope connecting the pilotboat with the vessel is supported on the latter by levers which, upon the deflection of the rope in either direction, by closing electric circuits, give indications of the altered course or operate the steering device of the pilotboat. The rope connecting the pilotboat with the vessel, and containing the leads, is constructed so that it will float.

11,820. LAUNCHING OF LIFEBUOYS. J. P. KIERAN, LIVERPOOL.

Claim.—By this invention the buoy is carried in a cage fastened to the deck rails and rests on the hinged bottom of it so that when the fastening is withdrawn by means of a cord the bottom swings downward and allows the buoy to fall into the water. Counter-weighted flags are attached, also a flare ignited by the automatic breaking of the seal, and these indicate the position of the buoy when afloat.

3,615. BALANCING THE THRUST OF PROPELLER AND LIKE SHAFTS. W. KNEEN, LONDON.

Balancing the thrust is effected by means of rollers mounted on bell-crank levers and running on a thrust-collar clamped to the propeller shaft. The cranked levers are pivoted to the ship at their middle and their extremities, farthest from the rollers, bear against helical springs which allow the rollers to yield to excess pressure. Ball-bearings may be used instead of rollers.

15,788. PILES, PIERS, WHARVES AND LIKE STRUCTURES. R. THOMSON, GLASGOW.

The invention relates to a pile or the like of reinforced concrete sunk by driving with or without water jets. Being set in positions, the base is filled in with concrete to form a solid mass that will efficiently support the load.

International Marine Engineering

OCTOBER, 1912

City of Detroit III; World's Largest Side Wheel Steamer

The latest addition to the magnificent fleet of the Detroit & Cleveland Navigation Company is the *City of Detroit III*, a vessel which is not only the largest side-wheel steamer in the world but also the most superbly finished craft of this type. The ship was built at the Wyandotte yards of the Detroit Shipbuilding Company according to designs from Mr. Frank E. Kirby, who also supervised its construction. The vessel was launched Oct. 7, 1911, and her trial runs were made early in June of this year. The principal dimensions of the ship are:

Length over all	470 feet.
Length on keel	455 feet.
Beam, molded	55 feet 4 inches.
Beam, over guards	96 feet 6 inches.
Depth at stem	22 feet.
Depth at stern	29 feet 3 inches.
Depth at guards	21 feet 3 inches.

The hull is built of steel with a double bottom, and is divided into eleven compartments by watertight transverse bulkheads extending from the keel to the main deck. The double bottom is divided at the center line and athwartships into fifteen watertight tanks. There are two decks below the main deck and three above. The main deck and housings on the main deck and orlop deck are also of steel. A steel superstructure is carried to the main deck, though the ceiling of the saloon deck is sheathed with galvanized iron, practically making her entire housing up to the saloon deck fireproof. A steadying tank of 100 tons capacity is provided amidships to check rolling in a heavy sea.

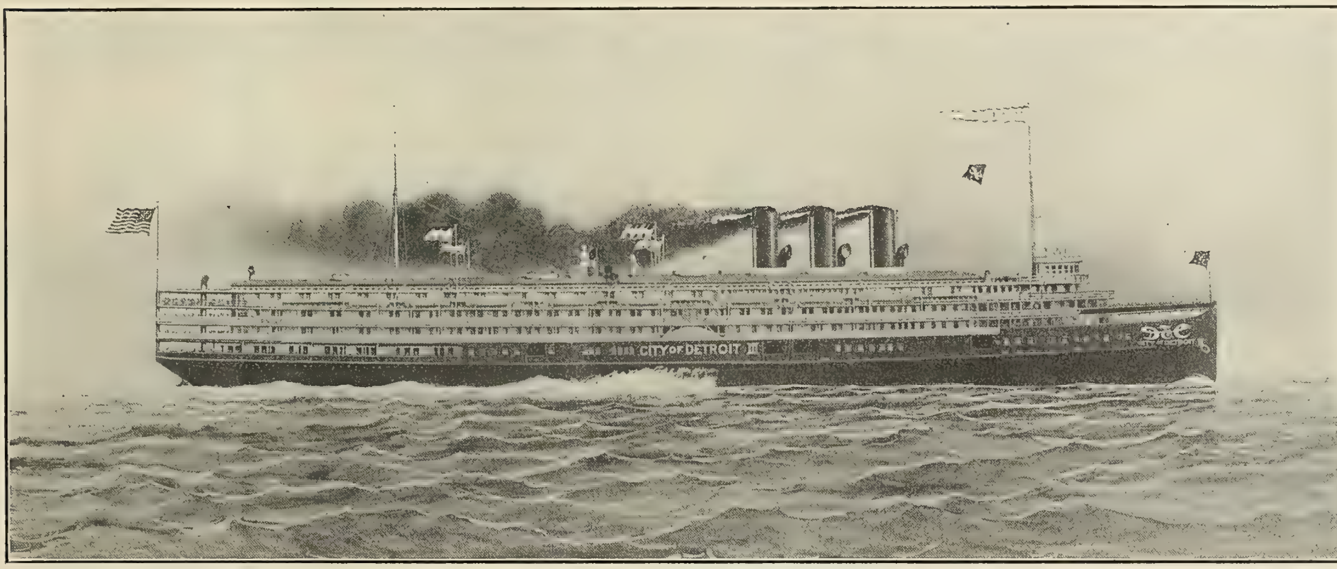


FIG. 1.—SIDE-WHEEL LAKE STEAMER CITY OF DETROIT III

Propelling Machinery

The main engine is of the inclined three-cylinder, compound, jet condensing type, having one high-pressure and two low-pressure cylinders. The estimated indicated horsepower is 8,000 at 30 revolutions per minute. The high-pressure cylinder is 62 inches in diameter, weighs 47,200 pounds, and is placed between the two low-pressure cylinders, which are 92 inches in diameter, all having a piston stroke of 102 inches. None of the cylinders is steam jacketed, but together with the two large tank receivers they are well insulated.

The high-pressure cylinder is fitted with poppet valves and Seckles cut-off gear, while the low-pressure cylinders have Corliss valves and gear. All the valves are operated by ordinary double-bar Stephenson link motion, and the cut-off in each cylinder has a range of from one-fourth to three-fourths of the stroke, adjustable from the starting platform.

The pistons are of cast steel, conical, and of single thickness, and are fitted with cast iron spring and junk rings. The piston rods, crossheads, connecting rods, guide struts and crankshaft are all of the highest quality of steel forgings supplied by the Midvale Steel Company.

The crankshaft is 25 inches in diameter in the engine bearings, and 27½ inches in diameter at the outer bearings and 71½ feet long from end to end, and weighs 103½ tons. It is made in three sections, connected by flanged couplings, which are recessed into the hubs of the crank arms. The crank arms are sunk into the pins, thus making the crankshaft perfectly rigid from end to end and avoiding all the trouble incidental to loose pins, wedges, etc. The crank shafting and pins are hollow throughout.

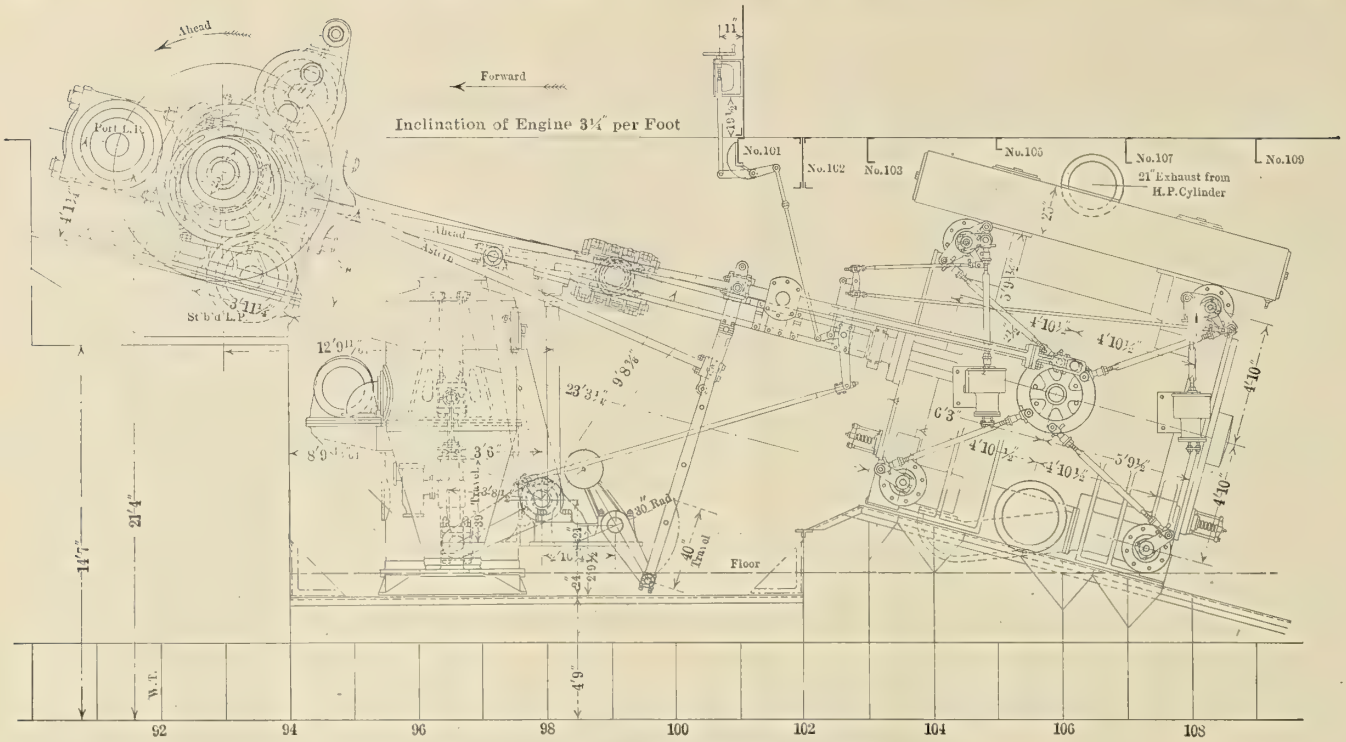


FIG. 2.—COMPOUND INCLINED ENGINE OF CITY OF DETROIT III

The connecting rods are 20 feet center to center and 13½ inches diameter at the center of their length. The crank pin end is fitted with round brasses lined with white metal, the caps being forged steel worked out of the main forgings. The crosshead end is forked and fitted with flat-bottomed brasses and wrought steel caps and bolts. Each connecting rod weighs approximately 10 tons. The piston rods are 12 inches in diameter, and the crosshead slippers are steel castings faced with white metal.

The main bearing pedestals, six in number, are massive steel castings rigidly bolted to the foundations, which are part of the ship structure, and braced together to insure stiffness when the engine is working. The caps are steel castings, box sections, the bearings being circular shells lined with white

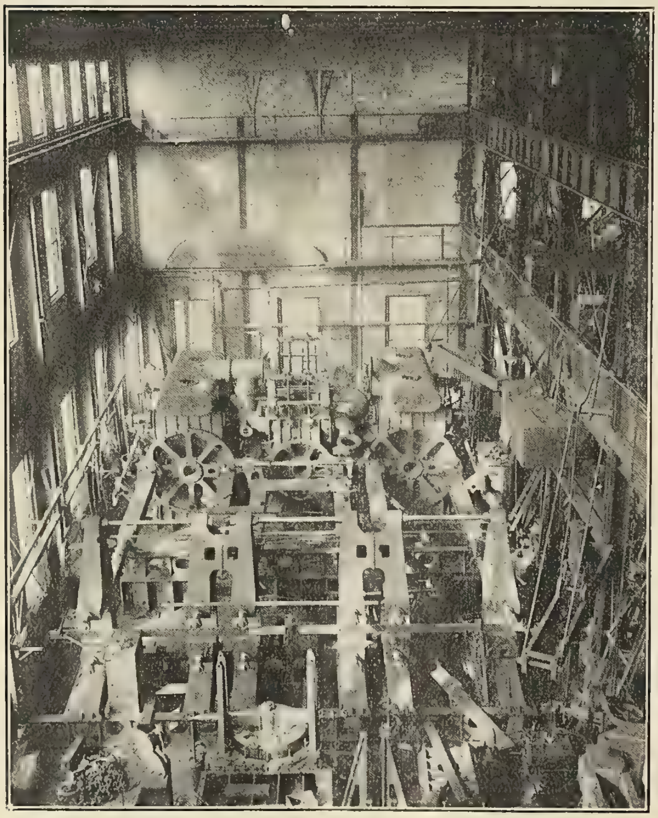


FIG. 3.—ENGINE ON ERECTION FLOOR OF BUILDER'S WORKS

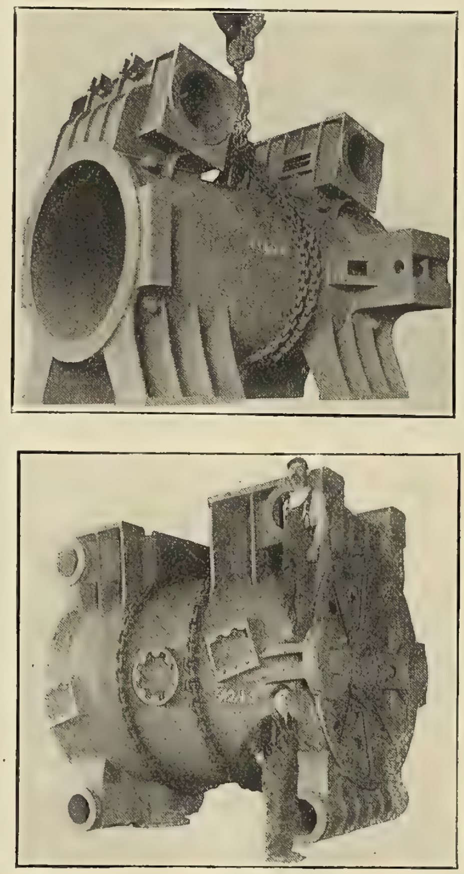


FIG. 4.—HIGH AND LOW PRESSURE CYLINDERS

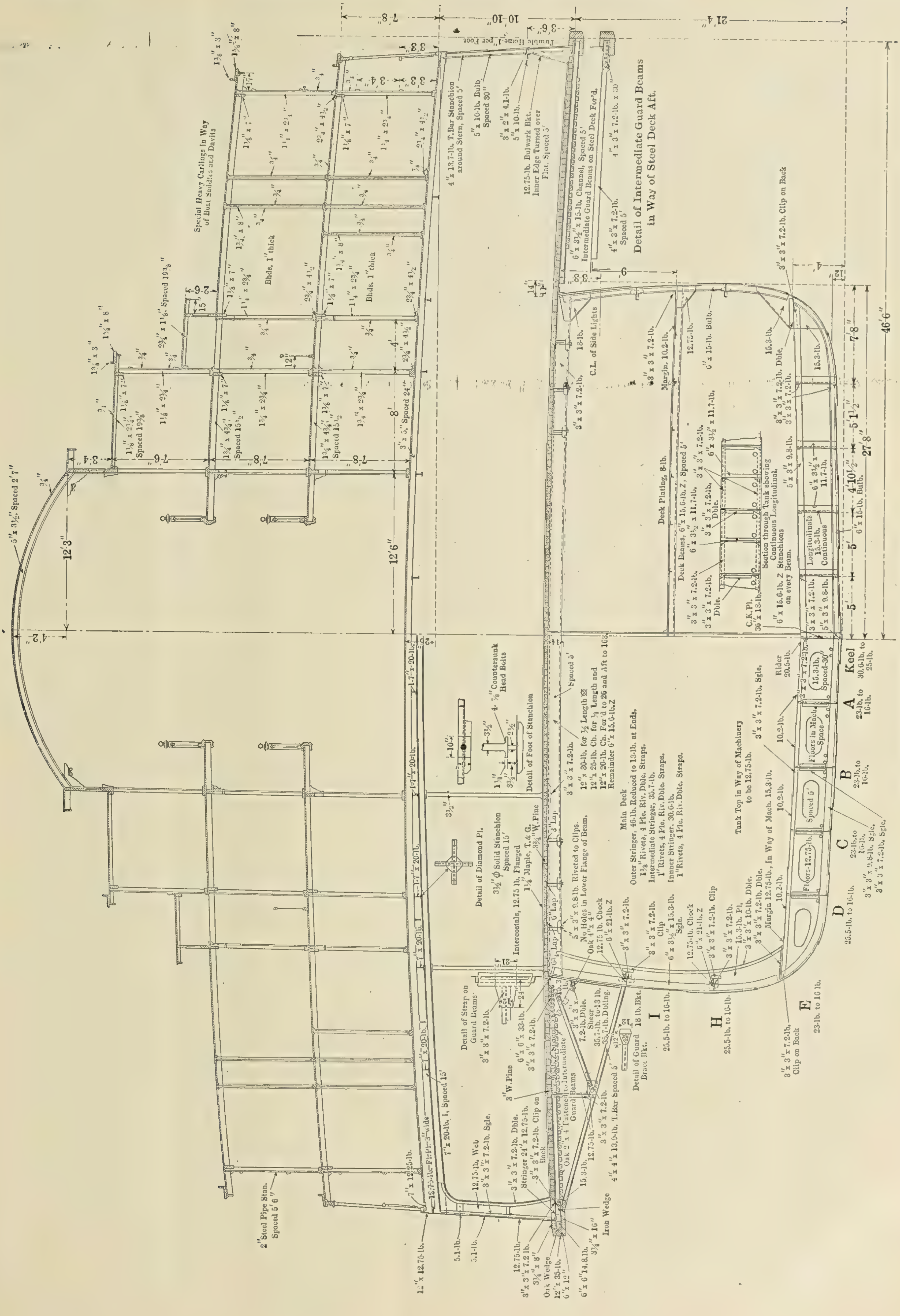
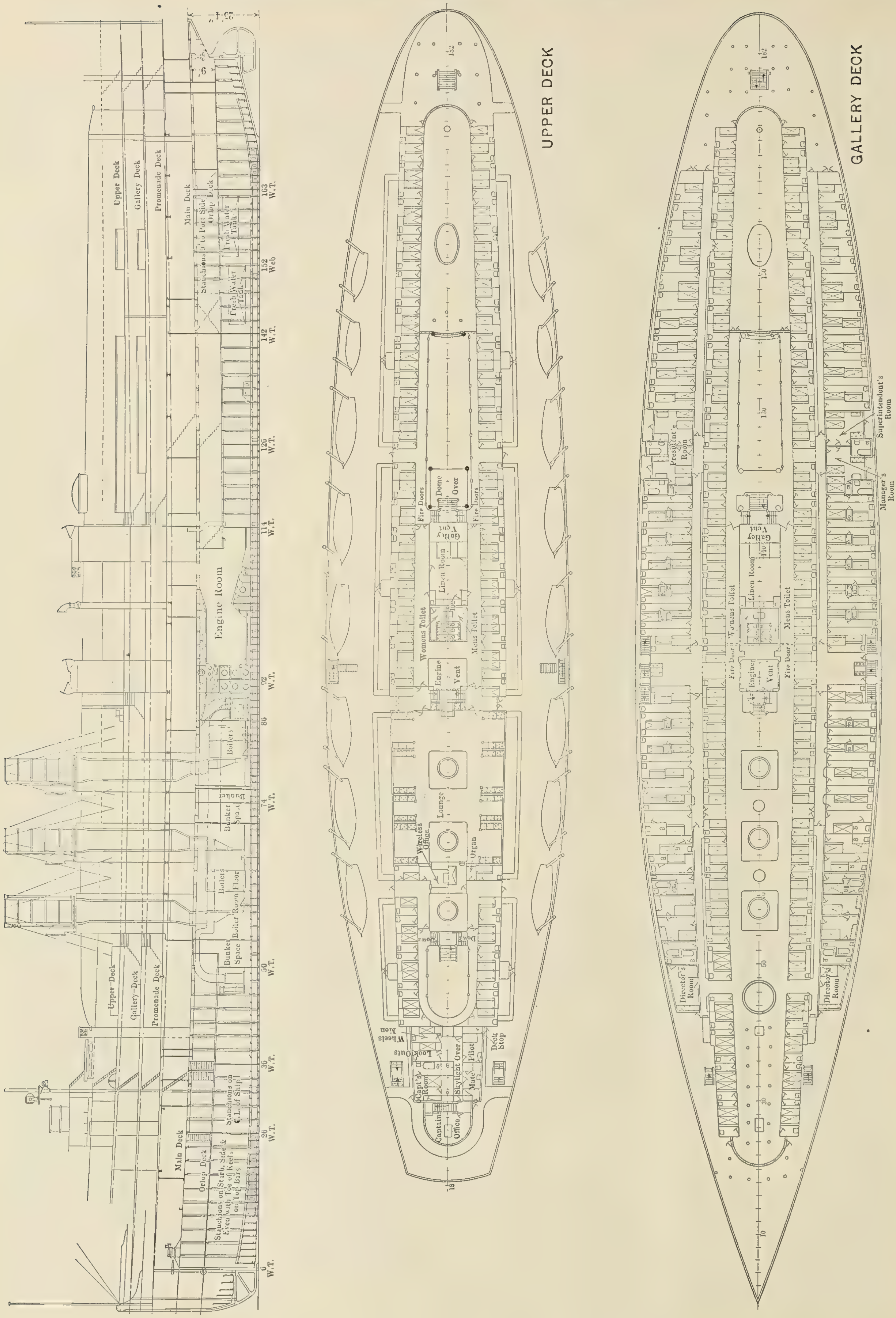


FIG. 5.—MIDSHIP SECTION OF CITY OF DETROIT III


UPPER DECK
GALLERY DECK
Upper Deck
Gallery Deck
Promenade Deck
Main Deck
Orlop Deck
Engine Room
Boilers
Bunker Space
Boiler Room Floor
Fresh Water Tank
Lounge
Organ
Wireless Office
Womens Toilet
Mens Toilet
Linen Room
Galley Vent
Engine Vent
Fire Doors
Dome Over
Skylight Over
Capt's Room
Captain
Office
Pilot
Mate
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Director's Room
President's Room
Superintendent's Room
Manager's Room

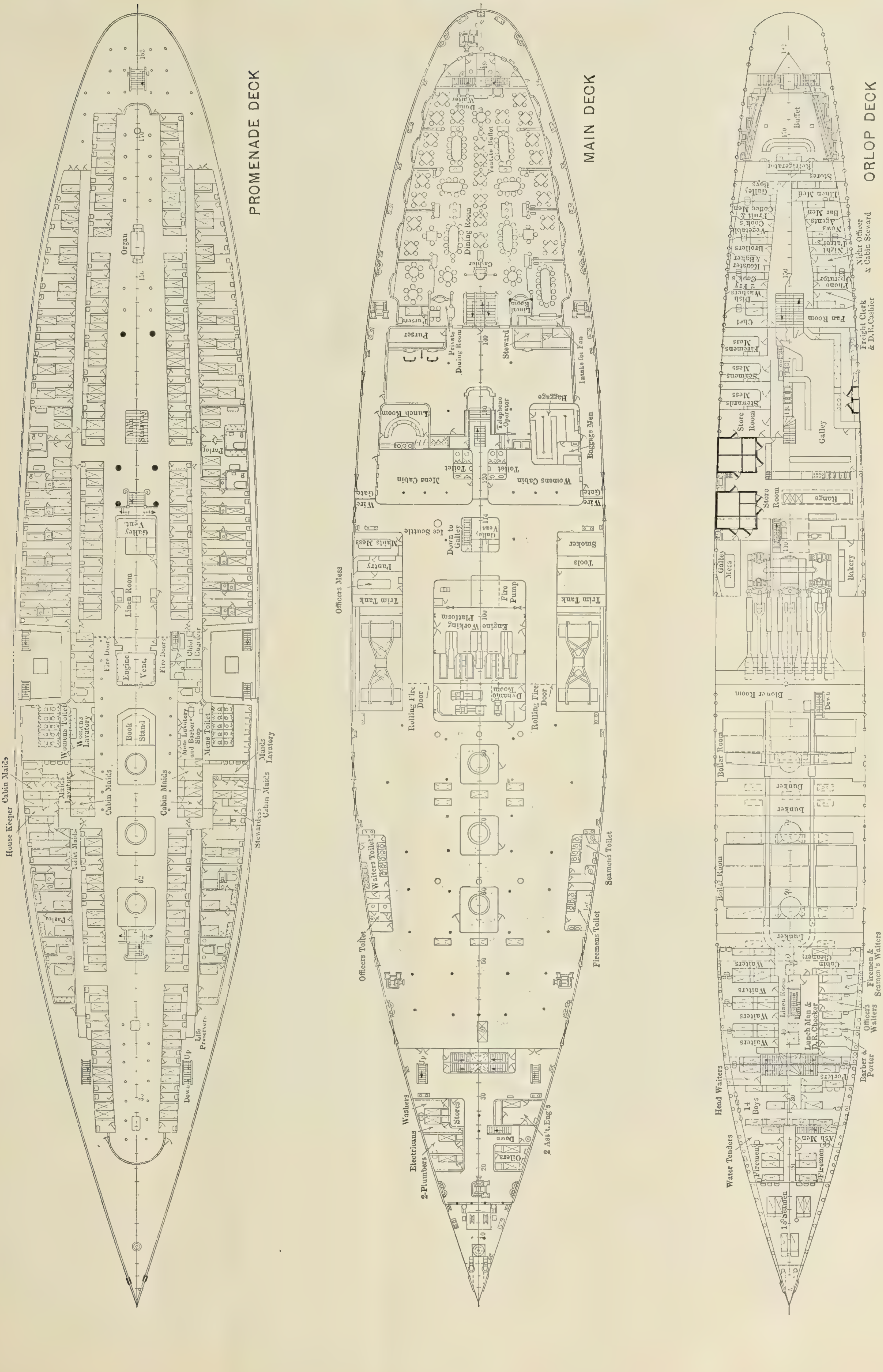


FIG. 6.—INBOARD PROFILE AND DECK PLANS OF CITY OF DETROIT III

metal. The guide struts are connected to the main bearing castings by a T-end, through which the main bearing bolts are extended and to the cylinder by round flanges and bolts. Midway in their length they are supported by vertical columns carried from the ship's floors.

Each cylinder is cast complete with its valve chests, thus avoiding all unnecessary and oftentimes troublesome joints. The front heads are also cast with the cylinders, and are strongly ribbed to distribute the strain from the guide struts. The finished low-pressure cylinders weigh approximately 27¾ tons each, and are excellent specimens of the founder's art.

The main air pumps, two in number, are of the vertical, single-acting plunger and bucket type, driven through heavy forged steel bell crank levers from the low-pressure crossheads. Each air pump cross-head also carries the plunger of a single-acting vertical feed and bilge pump.

The condensers are built up of riveted plate, and each low-pressure cylinder connects with its own condenser through a 24-inch exhaust pipe. The reversing of the engines is accomplished by means of a direct-acting steam gear, but a powerful hand-operated worm reversing gear is fitted for emergency use.

The handling gear levers are all conveniently grouped in a quadrant on the working platform above the cylinders, and, massive though the moving parts are, the reversing, etc., is accomplished with great ease and facility. The main throttle valve, 17 inches in diameter, is of the Schuette-Körting balanced type, operated by a simple lever, and is fitted with an 8-inch "by-pass" or maneuvering valve, which is sufficiently large to operate the engine up to half speed.

The lubricating system is elaborate and complete, as are the appliances to assist in the overhauling or lifting of the engine parts.

The paddle-wheels are unusually strong and heavy, and are designed to successfully meet the severe ice conditions met with in the early part of the season. The centers are of cast steel and the arms of forged iron, with the large gudgeon bosses forged on and bushed with lignum vitæ. The wheels are 30 feet 3 inches outside diameter, each fitted with eleven curved steel buckets, 14 feet 6 inches long by 5 feet wide, and on the outer ends are supported by a 14-ton steel truss. The radius rods are of steel fitted with brass bushings. The outboard bearings are heavy steel castings lined with white metal, and are adjustable in vertical and fore and aft directions.

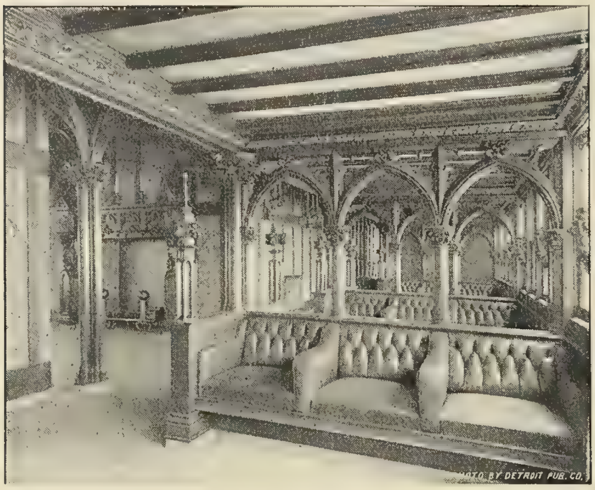


FIG. 7.—GOTHIC ROOM WITH FIRE PLACE (COPYRIGHT, DETROIT PUB. CO.)


FIG. 9.—MAIN STAIRWAY


FIG. 8.—DINING ROOM ON MAIN DECK


FIG. 10.—PALM COURT WITH FOUNTAIN

BOILERS

Steam at 160 pounds per square inch pressure is supplied by six cylindrical return tube boilers of the following dimensions: One single-ended 13 feet 9 inches diameter by 12 feet long with two 52 inches diameter Morison furnaces; one double-ended 13 feet 9 inches diameter by 22 feet long with four 52 inches diameter Morison furnaces; two single-ended 14 feet 8 inches diameter by 12 feet long with three 44 inches diameter Morison furnaces; two double-ended 14 feet 8 inches

diameter by 22 feet long with six 44 inches diameter Morison furnaces, making six 52 inches diameter and 18, 44 inches diameter furnaces, or 24 in all. The grates are all 5 feet 6 inches long.

The boilers are placed in two batteries of three each, and are fired in a fore-and-aft direction, the coal being carried in three athwartship bunkers. The Howden system of heated air forced draft is fitted, the air being supplied by three Sirocco fans direct driven by vertical American Blower Company engines. There are three funnels, with outer casings fitted up to the level of the top deck and single above.

The ashes are discharged overboard and well clear of the ship by means of six double jet ash ejectors, two in each stokehold. The stokeholds are well ventilated, and are remarkably cool even when the vessel is steaming at full power.

Auxiliary Machinery

The electrical equipment consists of two 75-kilowatt Kerr turbine-driven Northern generators, working at 1,800 revolutions per minute, 110 to 120 volts, and also one 35-kilowatt machine of the same make working at 3,600 revolutions. The two 75-kilowatt machines exhaust into a Dean jet condenser, with 10-inch by 18-inch by 18-inch air pump. There is a Blake vertical duplex compound ballast pump, 15 inches by 24 inches by 18 inches, pumping from the water bottom and discharging overboard or to the trimming tanks at will. The sanitary pump is also a Blake duplex compound, 8 inches by 14 inches by 12 inches, supplying water to the toilet rooms, also cooling water for the main engine. The fresh-water pump is a Blake duplex, 8 inches by 10 inches by 12 inches, drawing water for four fresh-water tanks of a combined capacity of 17,000 gallons. The water for drinking purposes is all purified by an electrical apparatus furnished by the Water Purifying Machine Company, of Buffalo, N. Y. In addition to the sprinkling pump for fire purposes there is also a Blake underwriters' pump, 16 inches by 9 inches by 12 inches, also an auxiliary feed pump, Blake duplex, 14 inches by 7½ inches by 12 inches.

FIG. 11.—GRAND SALOON (COPYRIGHT, DETROIT PUB. CO.)

Passenger Accommodations

The lobby on the main deck is of the Doric order of architecture, finished in bold figured selected mahogany inlaid with marquetry with scagliola columns, having carved capitals with brass bases. The ceiling panels are in composition relief finished in gold. The ceiling and wall fixtures are finished in burnished antique gold, the windows and doors glazed with plate and opalescent glass and the floor of interlocking rubber tiling.

The main dining room, aft of the lobby, is of imposing size. It is 90 feet long and 60 feet wide, affording accommodations for 350 passengers. The broad bay windows on either side afford a superb outlook over the water as the steamer speeds on her way. The simple yet harmonious decorations are of the Colonial style, the walls being wainscoted in old mahogany, 3 feet 6 inches high, with paneling above in old ivory adorned with exquisite carving in low relief on a golden yellow ground. The ceiling, which is supported by richly carved pilasters and columns, is paneled and decorated in harmonious colors. On the floor is spread a fine Wilton carpet in shades of green and old gold, while the furniture is executed in solid old mahogany of Colonial design. The 400 electric lamps are executed in old silver of Sheffield finish, and shine on spotless table linen, delicate china, beautiful cut glass and polished silver, completing a most artistic creation.

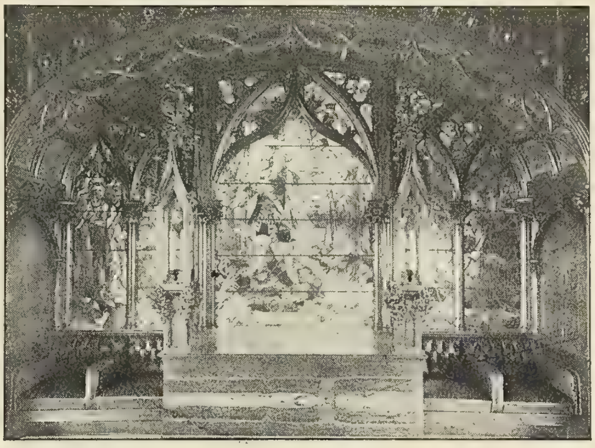


FIG. 12.—LA SALLE WINDOW IN GOTHIC ROOM (COPYRIGHT, DETROIT PUB. CO.)

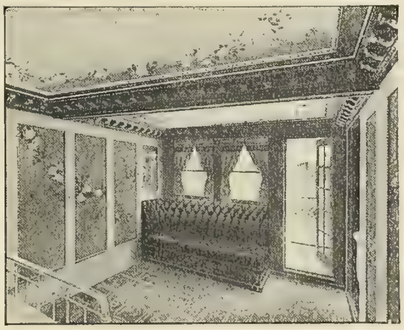


FIG. 13.—PARLOR WITH PRIVATE VERANDA

In the buffet, directly beneath the dining room, the ceiling, of groined Romanesque arches, is supported by massive columns, but the chief decorative feature is the wine casks of German manufacture beautifully carved. The floor is of Pewabic tile, and all woodwork is of white oak, including the furnishings. Other striking features of the room are paneled hogsheads with iron bands above the settees on either side of the room, the heads of the hogsheads being decorated with

burnt work in colors. The electrical fixtures are in the form of old hammered brass lanterns.

From the lobby the main stairway leads to the grand saloon on the promenade deck. It is designed in the Corinthian style; the main ceiling, with its massive and elaborately carved frames, with medallions and ornaments, being a masterpiece of carving and sculpture. Beautiful mural paintings, with the soft light properly illuminating, adorn the ceiling, and represent "Diana riding her golden chariot drawn by doves," "Nymphs playing in trees," and other mythological subjects. Directly above the grand stairway, and leading to the gallery and upper decks, is a spacious dome, rising to the upper deck house, which is supported by massive Corinthian columns and carved capitals. The dome has lunette panels with mural paintings surrounded by richly carved frames. The color scheme of the grand saloon is blended in gray ivory, pearl gray and white, and lightly embelished with Roman gold; the carpets throughout the main saloon are of the best Wilton, in shades of green for the promenade deck to harmonize with the mahogany woodwork and furnishings. On the gallery deck the carpets are in the shades of old rose in harmony with the gray tones of the decorations. The carved furniture, in Roman gold, is in exact keeping with the surroundings.

Aft of the main saloon and on the gallery deck is a sumptuous drawing room designed in the Marie Antoinette style. Here the walls and ceilings are paneled and finished in gray ivory enamel, with decorations in exquisite carving in low relief. The color scheme is gray and Cerulean blue, in exact shade to which the carpets and draperies are in perfect harmony. The furniture is carved in Italian walnut with Roman gold mounts; the upholstering is in velvet with a diminutive pattern, while the lighting fixtures consist of carved standards in Roman gold with silk shades.

A unique palm court on the upper deck directly above the drawing room forms a most pleasant place to linger and chat. It is finished in pure white with trellis panels and pilasters. There are beautifully carved flower stands filled with natural vines and flowers, a charming fountain from which water will play in a marble basin. In the center of the room is a Pergola decorated with trellis and natural vines supported by carved fauns and columns. The lighting is from concealed lamps in the cornice, and illuminates the bright Mediterranean sky partly concealed by natural vines.

The Gothic room, on the upper deck, is finished in old English Gothic, displaying the quiet grandeur of the interior of an old chapel or of an old European mansion. The woodwork is of elaborately carved English oak, embellished in strong colors and gold and finished in antique style. Large columns, supporting richly carved arches and spandrels, separate and divide this room into cozy recesses. Soft upholstered settees are built into these spaces, and so arranged with chairs to form convenient groups for parties. In the center of the room and between the stacks is a nook with a cheerful fireplace to add to the pervading effect of comfort. At the forward end is a large pipe organ, built in place, which fills the room with melodious music. At the after end is a beautifully stained glass window, being an allegorical representation of the early days of Detroit.

A modern ventilating system renews the air supply in all parts of the ship where such artificial circulation is required. With this system inside rooms are continually supplied with washed fresh air, making them as comfortable and desirable as outside rooms.

There are 600 staterooms, 25 parlors with bath, and 50 semi-parlors with private toilets. All the staterooms and parlors are supplied with hot and cold running water and telephones.

Safety Appliances

All of the latest approved types of mechanical equipment for the safety of the ship have been installed. There is a Marconi wireless system which places the vessel in communication with the shore and other vessels at all times while under way. Lifeboats and liferafts sufficient for all the passengers have been provided. A special feature is the installation of an automatic sprinkling system for protection against fire. There is an automatic fire alarm, which reaches all parts of the ship. It consists of an automatic thermostat which contains a small hollow copper wire which is connected to a sensitive diaphragm or plate, the latter sounding the alarm. The wire is installed in staterooms and other sections of the boat in such a manner that it is exposed so that a certain degree of heat causes it at once to sound the alarm signal. The wire is so small that it can be placed over moldings and around fancy scroll work, such as form part of the decorations in the staterooms and public rooms. The entire boat is divided into sections, eight staterooms to a section, and when an alarm is sounded in any part of the ship an indicator or annunciator shows in just what section of the boat the fire has started. The wire is sensitive only to heat, registering 140 degrees F. or more, a limit, however, which makes it susceptible to the heat of a burning newspaper if held near it. There are also fire walls of asbestos and galvanized iron lining, which divide the ship adequately for fire protection.

Trial Trip

The owner's trial trip of the *City of Detroit III.* took place on June 8. A run was made from Southeast Shoal to Long Point in Lake Erie, a distance of 133¼ miles. The time for the run was 6 hours 20 minutes, making an average speed of 21.05 miles per hour. The average horsepower developed was 7,606. No data were taken as to maximum speed, but during the trip one of the safety valves blew off at 140 pounds, and it is considered that the vessel is capable of a considerably better speed than 21 miles an hour when operated under a full head of steam. On the return trip from Long Point to Southeast Shoal the vessel was steered with the Akers auxiliary steam steering gear, the shift from the regular gear being made in four seconds.

Swan, Hunter & Wigham Richardsons, Ltd., of Wallsend-on-Tyne, has under construction for the Montreal Transportation Company for service on the Canadian canals and lakes a Diesel-engined ship having a deadweight carrying capacity of 2,400 gross tons on a draft of 14 feet, which will be equipped with electrical transmission. There are two sets of Diesel engines of 300 horsepower each, running at 400 revolutions per minute. Each engine is direct connected to an alternating-current generator, which supplies current for a compound-wound squirrel-cage induction motor coupled to the propeller shaft, which will turn the propeller at 80 revolutions per minute. This machinery arrangement is according to designs by H. A. Mavor, of Mavor & Coulson, Ltd., Glasgow.

The Diesel-engined Standard Oil barge No. 62, described in our March issue, recently made a trip of about 175 miles from New York to Providence, R. I., in a little over eleven hours. The barge was heavily loaded, but the amount of fuel oil consumed was only about 300 gallons, the price per gallon at that time being 4 cents (2d.). After discharging cargo in Providence the barge left in light condition for New York. The run on the return trip was under bad weather conditions, causing the propeller to be lifted out of the water frequently. Under such conditions, however, it was reported that the governing device worked very satisfactorily, and at no time did the propeller make more than 350 revolutions per minute.

United States Battleships Wyoming and Arkansas

BY HENDERSON B. GREGORY

Battleships Nos. 32 and 33, the *Wyoming* and *Arkansas*, are the two sister ships authorized by an act of Congress approved March 3, 1909. They are four-screw Parsons turbine vessels, designed for a speed of 20.5 knots, at 26,000 tons displacement and with the main engines developing 28,000 shaft-horsepower. The former was built by the William Cramp & Sons Ship & Engine Building Company, of Philadelphia, Pa., and the later by the New York Shipbuilding Company, of Camden, N. J. The contracts were signed Oct. 14 and Sept. 25, 1909, respectively, the prices being $4,450,000 (£914,000) and $4,675,000 (£960,000).

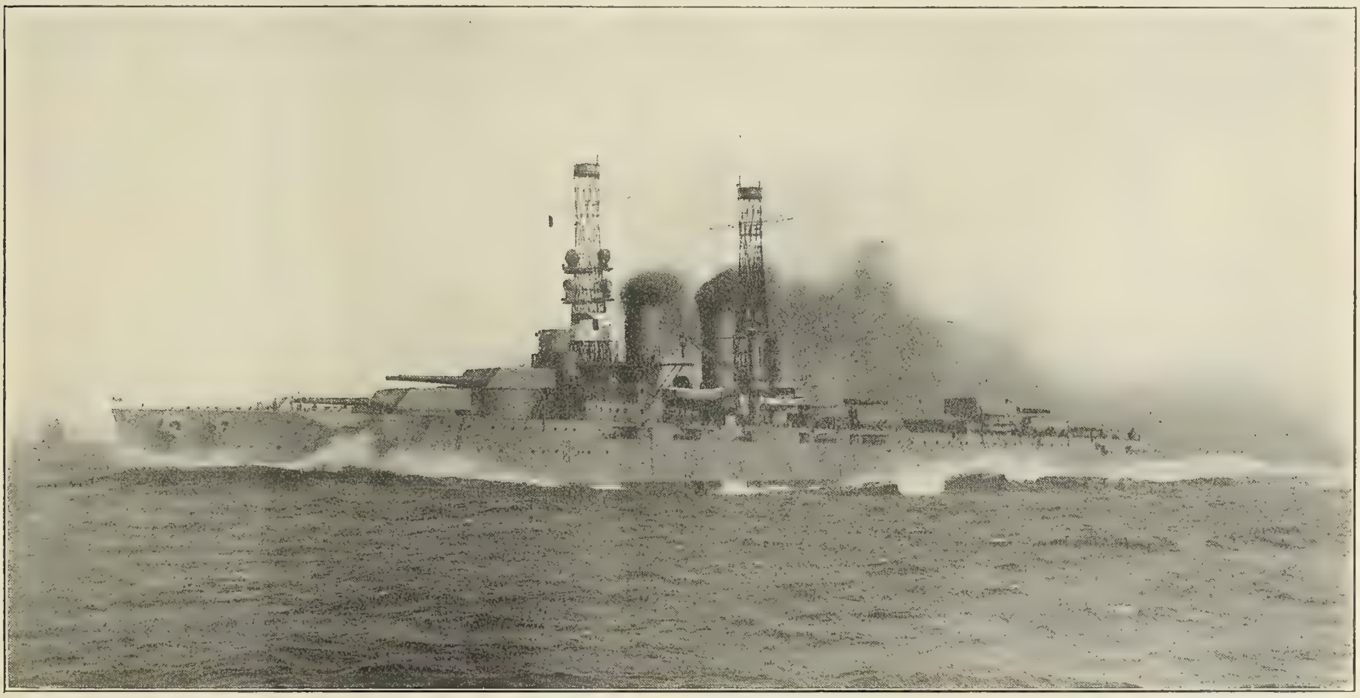


FIG. 1.—BATTLESHIP WYOMING ON FULL SPEED TRIAL (PHOTOGRAPH BY N. L. STEBBINS)

Principal Hull Dimensions

Length on L. W. L., feet and inches	554	0
Length overall, feet and inches	562	0
Breadth, extreme, at L. W. L., feet and inches	93	2⅝
Draft to L. W. L., feet and inches	28	6
Displacement corresponding, tons	26,000	
Ratio of length to beam	5.943	

Bridges, Decks, Etc.

Masts—There are two masts of the cage type, located on the center line of the vessel, one forward and the other aft of the smokestacks. The masts are equipped with searchlight platforms, wireless telegraphy outfit, signal yards, etc.

Bridges—There are two bridges—a flying bridge and bridge—the steering platform being at the elevation of the former.

Decks—The vessel has eight decks, as follows: (1) Bridge deck, on which is located the chart house. (2) Superstructure deck, containing the captain's, executive officer's and navigator's quarters. (3) Main deck, which is exclusively a weather deck except for the deck houses amidships, in which are located the galleys, blacksmith shop and foundry, and the admiral's and staff officers' quarters in the deck house forward; the main battery is also on this deck. (4) Gun deck, where are located the 5-inch battery, wardroom quarters forward, warrant officers' quarters, petty officers' and crew's quarters, sick bay, laundry and offices aft. (5) Half-deck, extending from stem to turret No. 3, on which are the junior officers' quarters. (6) Berth or protective deck, containing storerooms forward, coal bunkers amidships, crew's space, refrigerating plant and workshop aft. (7) Upper platform equipped with storerooms, chain lockers, windlass machinery, magazines, handling rooms, central station, coal bunkers, etc. (8) Lower platforms, where are located stores, torpedo room, magazines, handling rooms, dynamo rooms, steering gear and coal bunkers.

Hold—In the hold are trimming tanks forward and aft, stores, engine and boiler rooms and coal bunkers.

Double Bottoms—The usual double bottom compartments are provided. Those under the forward fire-rooms are fitted for reserve feed tanks and those amidships, between the engine and fire-room space, are provided for fuel oil.

Battery

The main battery of twelve 12-inch guns is located on the main deck. The guns are arranged in pairs in six turrets on the center line of the vessel. Turrets Nos. 1 and 2 can train on either broadside and dead ahead, the latter being elevated so as to fire ahead over the top of the former. The other turrets are grouped in pairs aft, Nos. 3 and 4 being just forward of and Nos. 5 and 6 abaft the engine hatches. In each case the forward turret is elevated, permitting direct astern fire for turret No. 5 over the top of No. 6, and allowing No. 3 turret to train on either broadside and well aft.

A secondary battery of twenty-one 5-inch rapid-fire guns for torpedo defense is also provided, together with the following smaller guns:

Four 3-pounder saluting guns.
Two 1-pounder guns for boats.
Two 0.30-inch machine guns.
Two 3-inch field pieces.
There are also two 21-inch submarine torpedo tubes.

Boats Carried

The following boats are carried on the main deck and in skid deck beams at the superstructure deck level:

Two 50-foot steam cutters.
One 40-foot steam cutter.
One 40-foot gasoline (petrol) motor barge for the admiral.
Two 40-foot motor sailing launches.
Two 36-foot sailing launches.
One 31-foot racing cutter.
Two 30-foot cutters.
Two 30-foot whale boats.
Two 24-foot dinghies.
Two 14-foot punts.

Two electrically-operated boat cranes are provided for handling all boats except the whale boats, which are hung

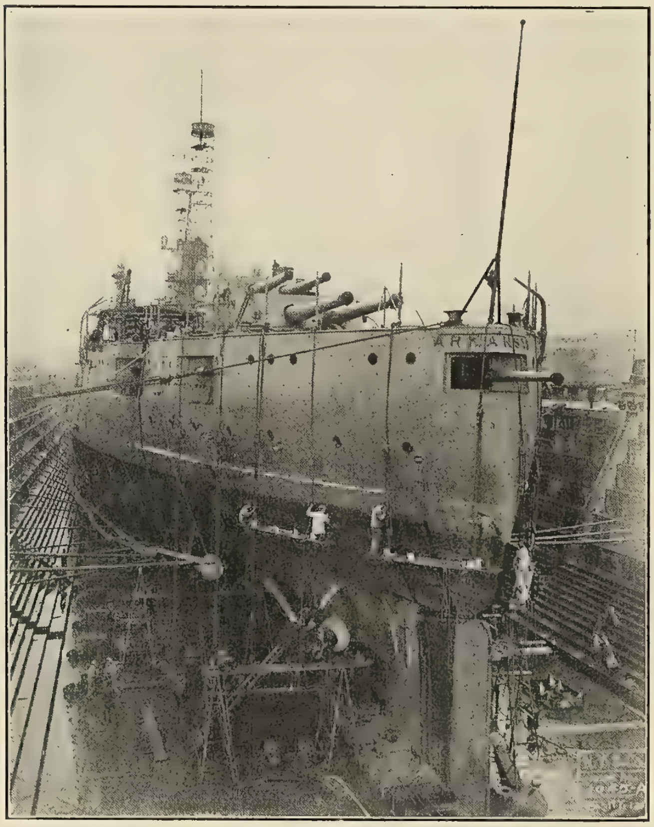


FIG. 2.—ARKANSAS IN DRYDOCK PREVIOUS TO TRIAL TRIP (PHOTOGRAPH BY N. Y. SHIPBUILDING CO.)

in davits aft on the port and starboard sides. Each crane is provided with two electric motors—one for turning and the other for hoisting. On the top of each crane is a platform for searchlights.

Steering Engine and Gear

The steering engine is located on the lower platform in a compartment just abaft of the engine rooms, access being from the starboard engine room.

The steering engine shaft is led aft to the tiller room, where is located the main steering gear, consisting of a right and left-hand screw, on which are two driving nuts direct connected by side rods to the crossheads on the rudder stock. The screw is operated through gearing by either the steering engine or the emergency hand steering gear, either of which may be disconnected when not in use.

Engine Data

	Arkansas.	*Wyoming.*
Type	Hyde Windlass Co., inclined engine.	Williamson Bros., vertical engine.
Cylinders, number	2	2
Diameter, inches	18	21
Stroke, inches	14	16

Anchor Windlass

This engine is located on the upper platform forward. It has two vertical shafts driven by worm gearing direct from a worm on the engine crankshaft. Each vertical shaft has at its upper end, at the main deck, a wildcat that are arranged to operate together or independently of each other.

Engine Data

	Arkansas.	*Wyoming.*
Type	Hyde Windlass Co., horizontal engine.	Williamson Bros., horizontal engine.
Cylinders, number	2	2
Diameter, inches	17	16
Stroke, inches	14	16

Coaling Engines and Gear

This outfit consists of two engines located on the gun-deck amidships. Each engine, through miter gears, drives an athwartship shaft, which in turn drives port and starboard fore and aft shafts, to which are geared five winch heads each, that can be thrown in or out of gear at will. The athwartship shafts are cross-connected so that either engine can operate all winch heads if necessary.

Engine Data

	Arkansas.	*Wyoming.*
Type	Hyde Windlass Co., vertical engine.	Williamson Bros., vertical engine.
Cylinders, number	2	2
Diameter, inches	12	9
Stroke, inches	10	9

Miscellaneous Machinery

The usual complete equipment of motor-driven deck winches, laundry and culinary machinery, flushing and fresh water pumps, ammunition hoists and conveyors, turret hoists, rammers, training and elevating gear, torpedo air compressors and fire-room elevators are provided.

Fire Main—A complete fire main system is led throughout the vessel, with fire plugs at convenient locations on the various decks. The main is supplied by seven fire pumps located in the engine and fire-rooms. The two distiller circulating pumps can also be used as fire pumps in emergencies.

Sanitary System—The main sanitary system is supplied by the engine and fire-room fire and bilge pumps. It connects to all officers' lavatories, petty officers' and firemen's wash rooms, galleys, ash chutes, sick bay, baths, laundry, etc.

Aft there is an independent system for the crew's water closet and wash room on the gun-deck aft, which is supplied by two electrically-driven centrifugal pumps. Both systems have by-pass connections from the fire main for emergency use.

Fresh Water System—The fresh water system leads to all pantries, lavatories, galleys, laundry, etc. It is normally supplied by gravity tanks, two electrically-driven pumps being provided for filling these tanks from the main ship's tanks. The pumps can also be used for supplying the system should any or all the gravity tanks be out of commission.

Drainage System—The main drain is 15½ inches in diameter throughout its length. It extends from the after bulkhead of the forward fire-room in a single pipe along the starboard outboard side to the forward bulkhead of the starboard engine room, at which point it joins the engine room sections, which are cross-connected and lead to the main circulating pumps.

In each engine room there is a 5½-inch secondary drain connected to the fire and bilge pumps. It has branches to the bilge wells, main drain, shaft alleys and compartments aft, including trimming tanks and double bottoms.

A 5½-inch secondary drain independent of the former extends through the fire-rooms. It is connected to the fire and bilge pumps and has branches to the bilge wells, double bottoms, compartments forward and the forward trimming tanks.

In addition to the former there is a 5-inch independent

drain in each fire-room direct connected to the fire and bilge pump in same compartment.

Ventilation—Artificial ventilation is provided for all quarters, living spaces and compartments requiring same. The air is supplied on the plenum system, except for the toilet spaces, where the exhaust system is used. The system comprises motor-driven fans located at convenient points throughout the vessel, from which the air ducts radiate to the various spaces to be ventilated.

Heating System—The staterooms, quarters and crew's spaces are heated by the ventilating system, steam coil thermo-tanks being introduced in the air ducts for heating the air supplied these spaces. The thermo-tanks can be by-passed when desired.

All other parts of the vessel to be heated are provided with the usual pipe-coil radiators.

Main Engines

The propelling machinery consists of Parsons turbines, designed to run at 330 revolutions per minute when developing 28,000 shaft-horsepower. They are arranged on four lines of shafting, as shown in sketch, Fig. 3.

The arrangement provides six ahead and four astern turbines, each low-pressure turbine embodying an astern turbine in the after end of its casing.

For ahead motion the outboard shafts are driven by the medium high-pressure turbines, and the inboard shafts by the low-pressure ahead turbines alone, or in combination with the I. P. C. and H. P. C. turbines, as described in the following paragraphs:

Full Speed Ahead—Only four turbines are used for this purpose, steam being admitted to the medium high-pressure turbines and expanded through the low-pressure ahead turbines into the condensers. Under this condition the astern and cruising turbines revolve idly in a vacuum, which is maintained through the drain connections.

High Cruising Speeds—Five turbines are used at these speeds, steam being admitted to the I. P. C. turbine, thence through the medium high-pressure turbines and the low-pressure ahead turbines, exhausting into the condensers; the remaining turbines revolving idly in a vacuum.

Low Cruising Speeds—All six ahead turbines are used for this combination, steam being admitted to the H. P. C. turbine and expanded successively through the I. P. C. turbine, medium high-pressure turbines and the low-pressure ahead turbines, exhausting into the condensers; the astern turbines revolving idly in a vacuum.

For astern motion all four astern turbines are used. The outboard shafts are driven by the high-pressure astern turbines and the inboard shafts by the low-pressure astern turbines, steam being admitted to the former and expanded through the latter into the condensers. Under this condition all the ahead turbines revolve idly in a vacuum.

Non-return valves are fitted in the receiver pipes between the H. P. C. and I. P. C. turbines, and between the I. P. C. and medium high-pressure turbines, as shown in Fig. 3, to prevent back flow of steam when changing from the low to high-speed cruising combination, or from high cruising to full-speed conditions.

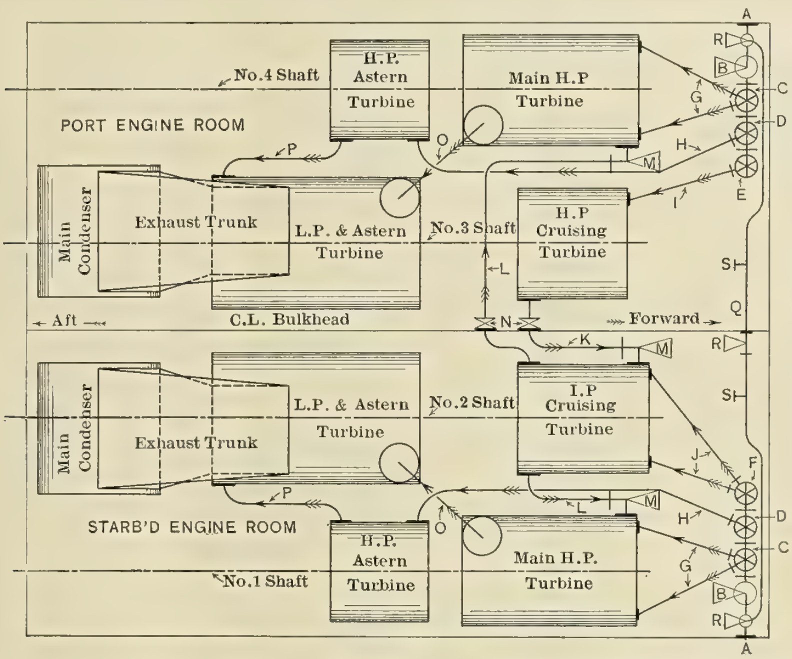
The turbines are controlled at the working platforms at forward end of engine rooms, where the regulating valves for admitting steam to the different turbines are located.

Turbines—Each turbine is composed of two essential parts; first, the fixed part or cylinder, and, second, the moving part or rotor. In the cylinder are mounted the guide blades and on the rotor the moving blades. The cylinders are of hard, close-grained cast iron, divided into two parts at the axis on a horizontal plane, the lower half being provided with feet for bolting to the seating. Each rotor is built up of a drum of forged steel, securely fastened to a cast steel wheel at each end, that is, shrunk on and keyed to the rotor shaft.

The dummies and rotor shaft glands are steam-packed with the usual labyrinth packing. A micrometer for measuring the dummy clearances is provided at the forward end of each ahead turbine.

Main Bearings—There is a main bearing at each end of each turbine for supporting the rotor. All bearings consist of a pedestal bolted to the turbine casing, except those for the high-pressure astern turbines, which are cast solid with the casing and fitted with bottom brass and cap.

Thrust Block—Each turbine, except the high-pressure astern, is provided with a thrust block at the forward end, consisting of a number of brass rings, in halves, fitted into corresponding collars on the shaft. The lower half of each bearing is for taking the ahead and the upper half the astern thrust.



MARK	DESCRIPTION OF PART
A	14" Main Steam from Boilers
B	14" Engine Stop and Governor Valve
C	14" Regulating Valve, M.H.P. Turbine
D	13" " " H.P. Ast. "
E	10½" " " H.P.C. "
F	14" " " I.P.C. "
G	10½" Steam to M.H.P. Turbine
H	13" " " H.P. Ast. "
I	10½" " " H.P.C. "
J	10½" " " I.P.C. "
K	* Steam from H.P.C. to I.P.C
L	* " " I.P.C. to M.H.P.
M	* Non-Return Valve
N	* Cut-Out Valve
O	† Steam from M.H.P. to L.P. Ahead
P	29" " " H.P. Ast. to L.P. Ast
Q	8" Main Cross-Connection
R	8" Stop Valve
S	7½" Auxiliary Steam Connection

* 17" for Arkansas, 18" for Wyoming
† 43" " " , 44" " "

DIAGRAM
ARRANGEMENT OF MAIN ENGINES AND PIPING

FIG. 3.—SKETCH OF MACHINERY ARRANGEMENT ON THE ARKANSAS AND WYOMING

All main bearings, thrust bearings and line-shaft bearings are fitted wih a closed system of forced lubrication, as described later.

Governor—Each line of shafting is provided with a governor designed to operate at about 400 revolutions of the main turbines.

Turning Gear—A power turning gear is fitted to each line of shafting. That for the *Arkansas* is electric, consisting of a 10-horsepower reversible Diehl motor for each shaft, and for the *Wyoming* steam engines are used, each being a double engine with cylinders 4 inches in diameter by 4 inches stroke. Provision is also made for turning by hand with a ratchet.

Lifting Gear—An efficient lifting gear is provided for all turbines. The lifting mechanism is hand operated.

Shafting

There are four lines of shafting, a pair port and starboard, respectively.

The outboard shafts are in two sections each, consisting of one line shaft supported by a spring bearing and a propeller shaft, extending through the stern tube and supported by the strut and stern-tube bearings. The inboard shafting is in four sections each, there being two line shafts supported by three spring bearings, one stern-tube shaft carried by the stern-tube bearings, and a propeller shaft supported by one strut bearing.

All stern-tube and strut bearings are lined with lignum vitæ, and the shafts are composition bushed at these bearings. The shafting within the stern tube is covered with a composition casing.

The inboard coupling consists of a sleeve, secured by four keys and two half collars or segments to the stern tube shaft and to the coupling disk on the line shaft by fitted bolts.

The outboard coupling is of the split-sleeve type, consisting of two half sleeves secured to each shaft by two keys, the half sleeves being secured together by bolts.

Shaft Data—Where differences exist both figures are given, the letters A and W being used to designate *Arkansas* or *Wyoming*, respectively.

MAIN TURBINE DATA.

	Arkansas.						Wyoming.					
Motor drums:					Diameter.	Length.					Diameter.	Length.
Main H. P., inches					71	114					74	109¾
H. P. cruising, inches					71	63½					73	63½
I. P. cruising, inches					70	72½					72	72½
L. P. ahead, inches					97	87⅝					101	87⅝
H. P. astern, inches					71	36¼					71	36¼
L. P. astern, inches					71	44⅛					71	44½
Number of expansions:												
Main H. P. and L. P. ahead, each						6						6
H. P. C. and I. P. C., each						3						3
H. P. astern and L. P. astern, each						4						4
Turbine casings, diameter, inches, each expansion:												
Main H. P.	73¼	74¼	75½	77½	80	83½	76¼	77¼	78½	80½	83	83
L. P. ahead	107½	111½	117½	128	128	128	111½	115½	121½	128	128	128
H. P. C.				72¼	72⅝	73⅛				74½	74⅞	75⅜
I. P. C.				72½	73¼	74¼				74¾	75⅜	76¼
H. P. astern			72¾	73¾	75	77			75¾	76¾	78	80
L. P. astern			80	83½	83½	83½			83	86½	86½	86½
Length of casing for each expansion and diameter noted above:												
Main H. P., inches	17¼	17	17 13/16	18⅝	19½	24 9/16	17¼	17	17 13/16	18⅝	19½	20 5/16
L. P. ahead, inches	12 13/16	13	15 3/16	15¼	15⅜	16½	12 13/16	13	15 3/16	15¼	15⅜	16½
H. P. C., inches				18½	18½	25¾				18½	18½	25¾
I. P. C., inches				23½	23½	24⅜				23½	23½	24⅜
H. P. astern, inches			9¼	8¾	8¾	9			9¼	8¾	8¾	9
L. P. astern, inches			9¾	11 5/16	10 15/16	13⅛			9¾	11 5/16	10 15/16	13⅛
Rows of blading for each expansion:												
Main H. P.						13						13
L. P. ahead					3 of 7	3 of 6					3 of 7	3 of 6
H. P. C.						20						20
I. P. C.						18						18
H. P. astern						6						6
L. P. astern						5						5
Length of blades for each expansion, inches:												
Main H. P.	1⅛	1⅝	2¼	3¼	4½	6¼	1⅛	1⅝	2¼	3¼	4½	4½
L. P. ahead	5¼	7¼	10¼	13½	13½	13½	5¼	7¼	10¼	13½	13½	13½
H. P. C.				⅝	13/16	1 1/16				¾	15/16	1 3/16
I. P. C.				1¼	1⅝	2⅛				1⅜	1 11/16	2⅛
H. P. astern			⅞	1⅜	2	3			⅞	1⅜	2	3
L. P. astern			4½	6¼	6¼	6¼			4½	6¼	6¼	6¼

Rotor shaft and bearings:

	Length of Bearing, White Metal, Inches.	Diameter of Shaft at Bearings, Inches.	Diameter Axial, Inches.	Length Over All of Rotor Drum and Shaft, Feet and Inches.	Length of Bearing, White Metal, Inches.	Diameter of Shaft at Bearings, Inches.	Diameter Axial, Inches.	Length Over All of Rotor Drum and Shat Feet and Inches
Main H. P.	15	14	9	21—07¼	15	14	9 and 8	21—04
L. P. ahead	24	15	11	25—10¾	24½	15½	10 and 8	26—00¾
H. P. C.	12	14	11	15—02¾	12	14	9	15—02¾
I. P. C.	12	14	11	16	12	14	9	16—00⅜
H. P. astern	10	14	9	11—02¾	10	14	9	11—03¼
L. P. astern	24	15	11	With ahead	24½	15	11	With ahead

Thrust bearings:

	M. H. P., Each.	L. P., Ahead, Each.	H. P. C., Each.	I. P. C., Each.	M. H. P., Each.	L. P., Ahead, Each.	H. P. C., Each.	I. P. C., Each.
Collars on shaft, number	17	17	8	8	17	17	8	8
Thickness, inch	0¾	0¾	0¾	0¾	0¾	0¾	0¾	0¾
Distance between, inches	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16
Outside daimeter, inches	17¾	17¾	17¾	17¾	18¼	18¼	18¼	18¼
Inside diameter, inches	12½	12½	12½	12½	12½	12½	12½	12½
Number of shoes, top	16	16	7	7	16	16	7	7
Number of shoes, bottom	17	17	8	8	17	17	8	8

Line shaft, diameter outside, inches	12⅛
At journals, inches	12¾
Axial hole, inches	8
Stern-tube shaft, diameter outside, inches	12⅜
Axial hole, inches	7¼
Propeller shaft, diameter outside, inches	12⅜
Axial hole	7¼
Couplings, diameter, inches	22
Thickness, inches	3
Inboard coupling, diameter of sleeve outside, inches	22
Inside, inches	14⅛
Length of sleeve, inches	(W) 10, (A) 12
Thickness of collars, inches	1¾
Coupling bolts, number each coupling	8
Diameter (taper)* at face of coupling, inches	2⅜
Outboard coupling, length of half sleeves, inches	48
Bolts securing sleeves, number	16
Diameter, inches	(W) 1¾, (A) 1½
Spring bearings, diameter, inches	12¾
Length, inches	(W) 18, (A) 22½
Forward stern-tube bearings, diameter, inches	(W) 14⅝, (A) 14 9/16
Length, inches	48
After stern-tube bearings, diameter, inches	14⅝
Length, inches	60
Strut bearings, diameter, inches	14⅝
Length, inches	72

* Parallel bolts for inboard coupling of *Wyoming*.

Propellers

There are four three-bladed propellers, all outboard turning when going ahead. The blades and hubs are of manganese bronze and cast in one piece. The blades are true screw-machined to pitch.

Propeller Data

	Arkansas.	*Wyoming.*
Diameter of propeller, feet and inches	9 7	10 0
Hub, feet and inches	2 3	2 0½
Pitch, feet and inches	8 2 5/16	8 2.24
Ratio of diameter to pitch	1.17	1.22
Area, projected, square feet	36.145	41.06
Helicoidal, square feet	40.145	46.13
Disk, square feet	72.131	78.5
Ratio, projected to disk area	0.501	0.523
Helicoidal to disk area	0.556	0.588

Main Condensing Apparatus

The condensing outfits of each vessel are radically different. That for the *Wyoming* is the Weir uniflex condenser with dual air pump, while the system installed on the Arkansas is the ordinary type condenser with Parsons vacuum augmenter and twin air pump.

Main Condensers—There is one main condenser, located in the after end of each engine room, of the following principal dimensions:

	Arkansas.	*Wyoming*
Type	Ordinary cylindrical.	Weir Uniflux triangular section.
Maximum width over all, feet and inches	....	9 9
Depth over all, feet and inches	....	10 2
Inside diameter, feet and inches	10 0	....
Thickness of shell (steel), inches	½	9/16
Length between tube sheets, ft. and ins.	11 0	9 9½
Thickness of tube sheets, inches	1	1⅛
Tubes, number	8,466	8,746
Diameter, inches	⅝	⅝
Thickness, B. W. G., No	16	16
Cooling surface, square feet	15,235	14,007
Exhaust nozzle area, square feet	48	48
Diameter air pump suction, inches	9	14
Augmenter suction, inches	15	....
Circulating water inlet and outlet, ins.	30	29

Main Air Pumps—An air pump of the following principal dimensions is provided for each main condenser:

	Arkansas.	*Wyoming.*
Type	Blake, twin, vertical, single-acting.	Weir, vertical, dual pump.
Diameter steam cylinders, inches	(2) 17½	(1) 20
Water cylinders, inches	(2) 35	(2) 36
Stroke, inches	21	21
Diameter, wet suction, inches	12	12
Dry suction, inches	....	7½
Wet discharge, inches	10	10
Dry discharge, inches	....	4½

Main Circulating Pumps and Engines—Each main condenser is provided with a circulating pump of the following principal dimensions:

	Arkansas.	*Wyoming.*
Type pump	Worthington, bi-rotor, volute, centrifugal.	Centrifugal.
Capacity, gallons per minute	....	19,500
Diameter suction nozzles, inches	(2) 21	(2) 21
Discharge nozzles, inches	30	29
Impeller, inches	(2) 17½	54
Type engine	Terry turbine.	Compound reciprocating.
Diameter H. P. cylinder, inches	....	13
L. P. cylinder, inches	....	25
Stroke, inches	....	12
R. P. M., disigned	....	215

Augmenter Condenser (*Arkansas only*)—An augmenter condenser of the following dimensions is installed for each main condenser on the *Arkansas:*

Diameter of shell inside, inches	29
Thickness of shell (composition), inches	5/16
Length between tube sheets, inches	48
Thickness of tube sheets, inches	1
Tubes, number	685
Diameter, inches	⅝
Thickness, B. W. G.	16
Diameter of vapor inlet, inches	13
Air-pump suction	12
Circulating water inlet and outlet, inches	6

Feed and Filter Tank

A feed and filter tank of about 4,000 gallons capacity is located at a high level in each engine room. The filter chamber is in the top of the tank and has a capacity of about 700 gallons. The filter has an inner bottom of loose perforated plates and is divided into compartments, in which is placed the filtering material, by vertical division plates. These partitions are so arranged that the water in passing through the filter will flow under and over in succession.

Engine Room Auxiliaries

Auxiliary Condenser, Air and Circulating Pumps—There is an auxiliary condenser in each engine room of about 725 square feet of cooling surface, connected through the auxiliary exhaust pipe to all the auxiliary machinery. Each condenser has a 7½-inch by 4-inch by 12-inch independent air pump of the Blake vertical, simplex, double-acting, feather-weight type and an independent circulating pump as follows:

	Arkansas.	*Wyoming.*
Type pump	Alberger, volute.	Centrifugal.
Diameter of impeller, inches	10	26
Suction and discharge, inches	6	6
Type engine	Alberger turbine.	Reciprocating single-cylinder.
Diameter cylinder, inches	....	5
Stroke, inches	....	6

Feed-Water Heater—A feed-water heater, complete with all the necessary fittings, is located in each engine room on the discharge side of the main feed pumps. The heating agent is the exhaust steam, a back pressure being kept in the auxiliary exhaust line for this purpose by means of a spring relief valve at each condenser connection, opening toward the condenser. The heaters on the *Arkansas* are of the Schutte-Köerting film type of 257.6 square feet of heating surface each, and those on the *Wyoming* are of the Alberger Condenser Company triple-flow type, of 900 square feet heating surface each.

Main Feed Pumps—Two 14½-inch by 9½-inch by 18-inch main feed pumps of the Blake vertical, double-acting, single type are located in each engine room. The pumps have suctions from the main feed tanks and discharge to the boilers through the feed-water heaters or by-pass same.

Reserve Feed-Water Pump—A small reserve feed-water pump is fitted in the port engine room for use in port to pump make-up feed-water from the reserve feed tanks into the main feed tanks. The pump is a 6-inch by 6½-inch by 12-inch Blake, vertical, double-acting single type.

Fire and Bilge Pumps—Two Blake 12-inch by 10-inch by 18-inch vertical, double-acting, single fire and bilge pumps are provided in each engine room. They are arranged to draw water from the drainage system and sea, and discharge to the fire main, sanitary system and overboard.

Pipe Insulator Pumps—In each engine room is a 6-inch by 8-inch by 8-inch Blake vertical, double-acting, single pump for circulating water around the main steam pipe flange at bulkheads near magazines to prevent the transmission of heat through the ship's structure to the magazines.

Water Service—Conveniently located hose connections are provided in the engine rooms and shaft alleys for supplying water to the bearings and other parts that may require cooling.

Forced Lubrication—There is a complete system of forced lubrication in each engine room for the main, thrust and line shaft bearings and the main circulating pump engines.

The installation in each engine room embraces two 10-inch by 9-inch by 12-inch Blake vertical, double-acting, single oil pumps; three Schutte-Köerting film oil coolers on the *Arkansas* and one Alberger oil cooler on the *Wyoming;* one (8-inch by 7-inch by 8-inch on the *Arkansas* and 10-inch by 9-inch by 12-inch on the *Wyoming*) Blake vertical, double-acting, single circulating pump for the oil coolers; one oil drain tank of about 350 gallons capacity and the necessary piping and fittings.

The system functions as follows: The oil pumps draw oil from the drain tanks and deliver same via the oil coolers, or by-passing same, to the various bearings at a pressure of about 15 pounds per square inch. After the oil has passed through the bearings it is caught in troughs formed in the bases of the bearings and drained by gravity back to the drain tank, whence the cycle is repeated.

Settling tanks for cleaning the oil and oil storage tanks are provided in each engine room.

Boilers

The boilers, twelve in number, are of the Babcock & Wilcox watertube type, arranged in batteries of four each in three separate watertight compartments. They are designed to run the entire machinery installation at full power, with an average air pressure in the ash pits of not more than 2 inches of water.

The boilers are equipped for burning both coal and fuel oil.

The up-takes are of the usual design, and there are two smokestacks, each about 92 feet in height above the grates and 11 feet 6 inches in diameter.

Boiler Data—Where differences exist both figures are given, the letters A and W being used to designate *Arkansas* or *Wyoming,* respectively.

Number		12
Working pressure, pounds per square inch		210
Test pressure, pounds per square inch		315
Height to top of drum, feet and inches	13	10¼
Length on floor, feet and inches	9	01½
Width on floor, feet and inches	18	04½
Drum, diameter, inches		42
Length, overheads, feet and inches	20	02¼
Thickness, inch		00 11-16
Number of furnaces, each boiler		1
Furnace doors, each boiler		5
Grates, length, feet and inches	7	00
Width, feet and inches	17	00
Total grate surface, square feet	1,428	
Total heating surface, square feet	64,234	
Ratio, G.S., to H.S.	1 to 44.98	
Number of tube sections, each boiler	31	
2-inch tubes, each boiler	1,100	
4-inch tubes, each boiler	62	
Distance between headers, feet and inches	8	00
Area of each smoke-pipe, mean, square feet	(A) 102.07,	(W) 103.87
G.S. ÷ area through smokestacks	(A) 7	(W) 6.87
Kind of forced draft	Closed fireroom.	
Number of oil burners, each boiler	(A) 4,	(W) 8
Type of oil burners	(A) Schutte-Koerting,	(W) Peabody
Dry pipe, diameter, inches		6
Steam stop valve, diameter, inches		5½
Triple safety valve, diameter each valve, inches		4
Feed stop and check valves, main and auxiliary, diameter, inches		2½
Surface blow valve		1½
Bottom blow valves		1½

Fuel Oil System

As auxiliary to the usual coal-burning appliances, a complete oil-burning system is provided. The plant consists of two 7½-inch by 4-inch by 8-inch Blake heavy-pressure, vertical, double-acting duplex pumps, one in each engine room on the center line bulkhead. These pumps draw the fuel oil from the double-bottom tanks, located under the space between the engine rooms and the fire-rooms, and deliver same to the oil burners on the boilers.

There are two oil heaters of the Schutte-Köerting film type in each fire-room on the *Arkansas,* and one of Cramp's design in each fire-room on the *Wyoming,* through which the oil is delivered to the burners in the same fire-room. The heating surface of the two type heaters is 10.4 square feet and 23.29 square feet each, respectively. The oil may be by-passed around the heaters if necessary. There are cut-out valves in the supply pipe to each pair of boilers, fitted with emergency deck-operating gear.

Fire-Room Auxiliaries

Forced-Draft Blowers—Four forced-draft blowers are installed for each fire-room. They are located in specially constructed blower rooms just below the protective deck and above the center of each fire-room. The fans are in two sections each, of the Sturtevant multivane type, and each is driven by an electric motor controlled from the working level or the blower room at will. Air is supplied from the fire-room ventilators. The fan motor data are as follows:

	Arkansas.	*Wyoming.*
Type motor	Diehl.	G. E.
Revolutions per minute	890	965
Horsepower, each	33	45
Fan, diameter, inches	26½	29¼
Width, each section, inches	14½	16 1/16
Number of blades, each section	60	36

Auxiliary Feed Pumps—There are three 14½-inch by 9½-inch by 18-inch auxiliary feed pumps, one in each fire-room. They are of the Blake vertical, double-acting, single-type, and are arranged so that any pump can feed any boiler.

Fire and Bilge Pumps—In each fire-room there is a Blake 12-inch by 10-inch by 18-inch vertical, double-acting, single fire and bilge pump, arranged to draw water from the bilge, the drainage system and the sea, and discharge to the fire main, sanitary system and overboard.

Ash Hoists—The port ventilator in each boiler compartment is fitted with all the necessary gear for hoisting ashes. There are three ash-hoist engines of the two-cylinder reversible type, one for each fire-room, located in the upper fire-room hatches. The cylinders are each 4½ inches in diameter by 4½ inches stroke. The hoists are operated from the main deck, where are located the ash chutes at the ship's side.

In addition to the ash hoist the following ash-handling apparatus is provided:

Ash Ejectors (*Arkansas only*)—Two 6-inch hydraulic ash ejectors, one port and the other starboard, discharging above the waterline, are provided in each fire-room. The water for discharging the ashes overboard is supplied by three 14-inch by 8½-inch by 12-inch Warren vertical, duplex, double-acting pumps, one in each fire-room.

Ash Expellers (*Wyoming only*)—A Metten hydraulic ash expeller, discharging through the bottom of the vessel, is fitted in each fire-room. Each expeller is provided with a De Laval steam turbine-driven centrifugal pump for discharging the ashes overboard.

Piping Systems

Main Steam Piping—The main steam piping is arranged in two symmetrical systems, one on each side of the vessel. The two lines are cross-connected in the forward fire-room and in the engine rooms. The branches from the boilers are 5½ inches in diameter each, and the lines proper are 7½ inches in the forward fire-room, increasing to 9½, 11, 12½ and 14 inches at each successive boiler connection. In the pipe passages, between the engine and fire-rooms, it is increased to 14½ inches in diameter and again reduced to 14 inches in the engine rooms. No steam separators are fitted.

Auxiliary Steam Piping—A 7½-inch auxiliary steam line, forming a connecting loop between the two sides of the ship, is led from the engine room main steam cross-connection through the engine rooms. From this line steam connections are taken for the various engine room auxiliaries, steering engine, etc.

In the fire-rooms the auxiliary steam consists of a small cross-connection between the port and starboard main steam lines, from which the branches to the auxiliaries are taken.

Steam connections for the forward dynamos and deck machinery forward are taken off the main steam cross-connection in the forward fire-room.

The after dynamos are supplied through connections from the main steam pipes in the after fire-room.

Auxiliary Exhaust Pipe—An auxiliary exhaust pipe is fitted throughout the machinery spaces and elsewhere as required for the various auxiliaries. Connections are provided to direct the exhaust steam into either the main or auxiliary condensers, either feed-water heater, or into the atmosphere through the after escape pipe at will. There are also connections for admitting the exhaust steam into the steam belts of the medium high-pressure and low-pressure ahead turbines when desired.

Main and Auxiliary Feed Pipes—The main feed pumps in the engine rooms take their suction from the main feed tanks and discharge viâ the feed-water heater, or by-pass same, to the boilers. There is a suction main from the main feed tanks to the auxiliary feed pumps in the boiler rooms. These pumps have direct connections to the boilers in their respective compartments, or can discharge into the main feed line to any boiler.

Interior Communication

The customary engine and fire-room telegraphs, gongs, time-fire device, telephones, voice tubes, etc., are fitted for transmitting orders and signaling to the various machinery compartments and other parts of the vessel.

Air Compressor Plant

Located in the engine room are nine* 11-inch by 11-inch by 12-inch Westinghouse steam-driven air compressors and two air reservoirs of about 45,000 cubic inches capacity each, for use in running pneumatic tools in the engineering department, blowing soot off the boiler tubes and for the gas-ejecting system for the guns.

Each compressor has a capacity of about 300 cubic feet of free air per minute at 150 pounds pressure.

A pneumatic main, independent of the gun gas-ejecting system, is led throughout the machinery space, with branches to the workshop, evaporator and dynamo rooms, from which the connections for pneumatic tools and blowing soot off boiler tubes are taken.

Evaporating and Distilling Apparatus

This plant is located on the berth deck, just forward of No. 3 turret, with the distillers in the evaporator room hatches at the gun-deck level. There are four evaporators of 312 square feet heating surface each, four distillers of 125 square feet of cooling surface each, and two evaporator feed-water heaters, with their accessories arranged to operate in double effect. The plant has a combined capacity of 25,000 gallons of water per twenty-four hours.

The following pumps, of the Blake vertical, double-acting, single type, are provided:

Two evaporator feed pumps, 4½ inches by 5 inches by 6 inches.

One distiller fresh-water pump, 4½ inches by 5 inches by 6 inches.

Two distiller circulating pumps, 12 inches by 14 inches by 16 inches.

Machine Shop

A well-equipped machine shop is located amidships between the engine hatches on the berth deck. The necessary machine tools for performing general repairs are provided. The tools are of the latest type, and each is driven by an independent electric motor.

There is also a well-equipped blacksmith shop and small foundry located on the main deck amidships.

Electric Plant

There are two dynamo rooms located on the lower platform, one forward and the other aft of the boiler compartments.

The generator installation in each dynamo room consists of two six-pole, compound-wound, 300-kilowatt General Electric generators, each driven by a two-stage horizontal Curtis turbine. Each generator will deliver at normal load 2,400 amperes of current at 125 volts when running at 1,500 revolutions per minute.

There is one condenser in each dynamo room for the exclusive use of the dynamo equipment. Each condenser has its independent air and centrifugal circulating pump and hot-well tank and pump.

The condenser and pump data are as follows:

Condenser Data

	Arkansas.	Wyoming.
Diameter inside shell, feet and inches..	4 10	4 0½
Thickness of shell, inches............	¼	5/16
Length between tube sheets, ft. and ins.	6 8½	7 3
Thickness of tube sheets, inches.......	1	1
Tubes, number	2,190	1,529
Diameter, inches	⅝	⅝
Thickness, B. W. G..........	16	16
Diameter exhaust nozzles, inches..	(2) 19	(2) 20
Air pump-suction, inches.....	(1) 6	(2) 5
Circulating water inlet and outlet, inches	9	10
Cooling surface, square feet..........	2,403	1,813.5

Circulating Pump and Engine Data

Type	Centrifugal.	Centrifugal.
Diameter impeller, inches.............	21	28
Steam cylinder, inches	6	5
Stroke, inches	6	6

Air Pumps—9-inch by 18-inch by 12-inch Blake vertical, twin, beam, single-acting, single steam cylinder.

Hotwell Pumps—4½-inch by 5-inch by 6-inch Blake vertical, double-acting, single.

Refrigerating Plant

There are five Allen dense-air ice machines, each capable of producing the cooling effect of 3 tons of ice per day. Two of the ice machines are located—one forward and the other amidships—for the forward and amidships magazine cooling systems. The three other ice machines are located just aft of the engine room hatches, one on the starboard and two on the port sides, and are fitted for cold-storage service, ice making and for the after magazine cooling systems. The piping is so arranged that any ice machine can be used on any magazine cooling system in emergencies.

There are four refrigerating rooms isolated by air locks and insulated with cork in the usual manner.

Torsion Meters

Each line of shafting is fitted wih a Gary-Cummings torsion meter for ascertaining the shaft-horsepower of the main turbines.

Trials

The contracts required five trials, as follows:

(*a*) A progressive trial over a measured mile course for standardizing the screws.

(*b*) A full-speed trial of four hours' duration in the open sea at the highest speed obtainable, with an average air pressure in the ash pits not exceeding 2 inches of water and not over 175 pounds steam pressure above the atmosphere at the medium high-pressure turbine. The average speed to be at least 20.5 knots.

(*c*) An endurance and coal-and-water-consumption trial of twenty-four hours' duration in the open sea, at as nearly as possible a uniform speed of 19 knots, the average not to fall below that figure. The trial to be conducted as nearly as possible under cruising conditions.

(*d*) An endurance and coal-and-water-consumption trial at 12 knots, under similar conditions to the preceding trial.

(*e*) A trial of two hours' duration at the highest speed obtainable, burning coal and fuel oil in combination.

The *Arkansas'* trials took place early last June, and the *Wyoming's* were just completed the middle of July.

* 9 for *Arkansas;* 8 for *Wyoming.*

The standardization trials of both vessels were run on the measured mile course at Rockland, Me. The weather was favorable on both occasions and the trials were most satisfactory. The maximum corrected speeds attained were 21.196 knots for the *Arkansas* and 21.323 knots for the *Wyoming.* A graphic comparison between the performances of the two vessels is given in Fig. 4. From the data obtained it was found to require 310.9 revolutions per minute of the main turbines to attain the contract speed of 20.5 knots, 284.4 revolutions per minute for 19 knots and 175.8 revolutions per minute for 12 knots for the *Arkansas,* and 302.5, 279.5 and 171.2 revolutions per minute, respectively, for the Wyoming.

All other trials were run in the open sea off the North Atlantic coast. Excellent weather prevailed throughout the trials, which were successfully conducted and all requirements easily met. Unfortunately, an accident to the H. P. C. turbine on the *Arkansas,* which occurred on the standardization trial, rendered it necessary to disconnect the turbine for the remaining trials and to conduct the 12-knot endurance trial of that vessel on the five-turbine combination instead of six turbines as intended.

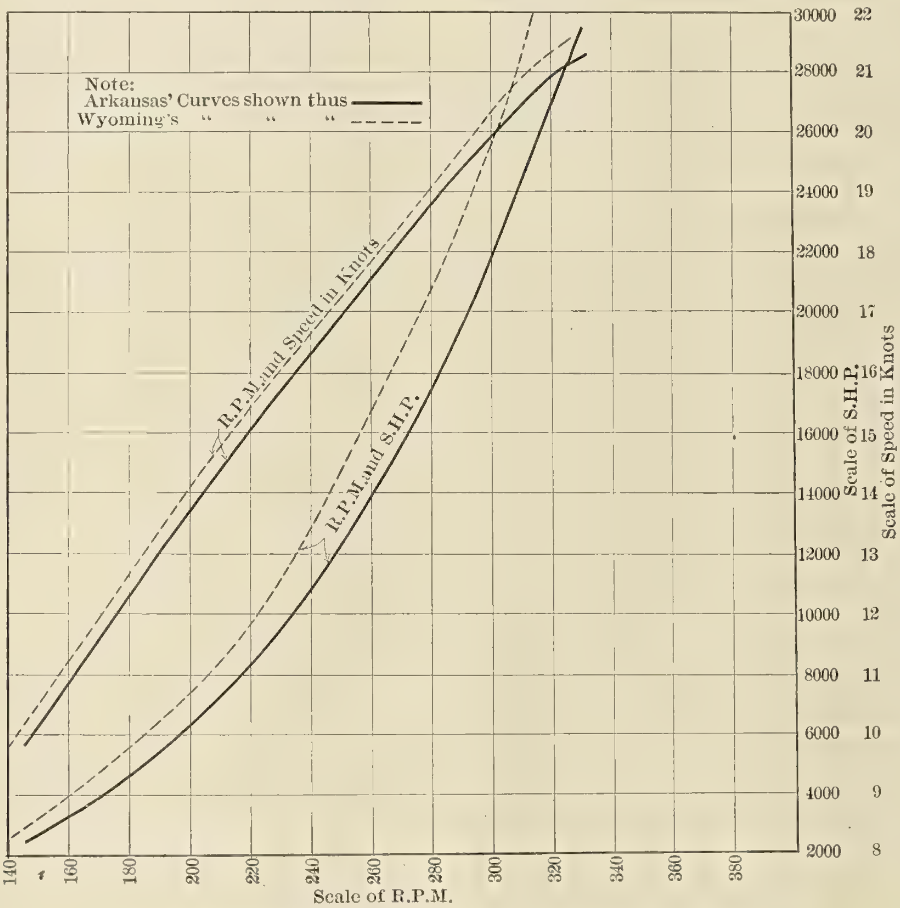


FIG. 4.—SPEED AND POWER CURVES FROM TRIALS OF ARKANSAS AND WYOMING

The average figures for shaft-horsepower, revolutions per minute and speed developed on the several trials are given below:

	Arkansas.	*Wyoming.*
4-hour full-speed trial:		
Shaft horsepower	28,533	31,437
Revolutions per minute	323.8	319.36
Speed in knots	21.05	21.223
24-hour, 19-knot endurance trial:		
Shaft horsepower	20,592	20,784
Revolutions per minute	291.3	282.6
Speed in knots	19.41	19.209
24-hour, 12-knot endurance trial:		
Shaft horsepower	4,354	5,353
Revolutions per minute	175.7	175.09
Speed in knots	11.993	12.266
2-hour coal and oil-burning trial:		
Shaft horsepower	28,043	28,889
Revolutions per minute	322.1	312.31
Speed in knots	20.989	20.979

The United States battleship *Pennsylvania,* authorized by act of Congress Aug. 22, is to have the following main characteristics: Length, 600 feet; beam, 97 feet; draft, about 28 feet 6 inches; displacement, about 31,000 tons; main battery, twelve 14-inch guns and four submerged torpedo tubes; secondary battery, twenty-two 5-inch guns. The vessel will be heavily armored and will have oil-burning boilers of the watertube type. The type of machinery has not yet been definitely determined, although it is expected that the speed of the vessel will slightly exceed the fastest American battleships. The cost of the ship, exclusive of armor and armament, will be approximately $7,425,000 (£1,525,000).

H. M. S. Oak, the third torpedo boat destroyer of the *Firedrake* type built for the British Admiralty by Messrs. Yarrow & Company, of Glasgow, was successfully launched Sept. 5. The *Oak* is 255 feet long, with a beam of 25 feet 7 inches, the propelling machinery consisting of Parsons turbines driving twin screws. Steam is supplied by three of the latest type of Yarrow boilers, fitted with the firm's patent feed heating device and arranged for burning oil fuel exclusively. The contract speed of the vessel is 32 knots.

The steamship *Nantucket,* of the Merchants & Miners' Transportation Company, sank at a railroad pier at Locust Point, Baltimore harbor, Sept. 2, after the lower forward hold of the steamer had been flooded with water to put out a fire which broke out in the cargo. The flooding of the hold caused the cargo to list and the vessel turned over on her beams end.

Vickers, Ltd., of Barrow-in-Furness, has just received a contract for a large oil tank steamer for the British Admiralty. This vessel will be engined with two Carels-Diesel engines.

Motor Ship Eavestone Fitted with Carels Diesel Engines

The first large British-built and British-owned Diesel-engined motor ship is the *Eavestone,* the hull of which was built at the yards of Messrs. Sir Raylton Dixon & Company, Middlesbrough, and the engines by Messrs. Richardsons, Westgarth & Company, Ltd., Middlesbrough, in conjunction with Messrs. Carels Bros., Ltd., Ghent, Belgium. The ship is 276 feet long, 40 feet 6 inches beam, displacement about 4,500 tons, deadweight carrying capacity about 3,200 tons. She is a twin-screw vessel with engines aggregating 1,000 horsepower, designed to give the ship a speed of 9½ knots.

The Carels type of engine, with which the ship is fitted, has been developed by Messrs. Carels Bros. in a most practical way by combining the results of this firm's previous development of the Diesel engine for stationary purposes with the best marine steam engine practice. It is impossible, of course, to build an oil engine exactly on the lines of a steam engine, because the functions of the two engines are totally different, and different types of valves and valve gear are necessary. Also the design of the cylinders of an oil engine to withstand high-pressures and high temperatures introduces a new problem. The construction of piston rods, crankshafts, bearings, engine framing and bed plates of an oil engine, however, can be made to conform to the design of a steam engine, and in order to combine these elements in the design of the marine Diesel engine, Messrs. Carels Bros., before turning their attention to marine work, consulted with the foremost marine engine builders in England, France and Germany, and obtained from them the benefit of expert marine engine construction as a foundation for the design of a practical and reliable marine Diesel engine. The Carels marine Diesel engine, therefore, is the result of the most careful adaptation of good marine engine practice and good oil engine practice.

The appearance of the Carels engine, as can be seen from the photograph and drawings of the *Eavestone's* engines shown herewith, is, therefore, about the nearest approach to that of a steam engine that has yet been developed. A close inspection of the drawings will show that the construction of the engine from the bed plate to the cylinders is practically a reproduction of steam engine design. The cylinders and valve mechanism, however, are in accordance with the successful development of the Diesel engine which this firm developed for stationary work. In the engines for the *Eavestone,* Messrs. Carels Bros. supplied the cylinders and the valve mechanism, while the other parts of the engines were built by Messrs. Richardsons, Westwarth & Company, Ltd. These

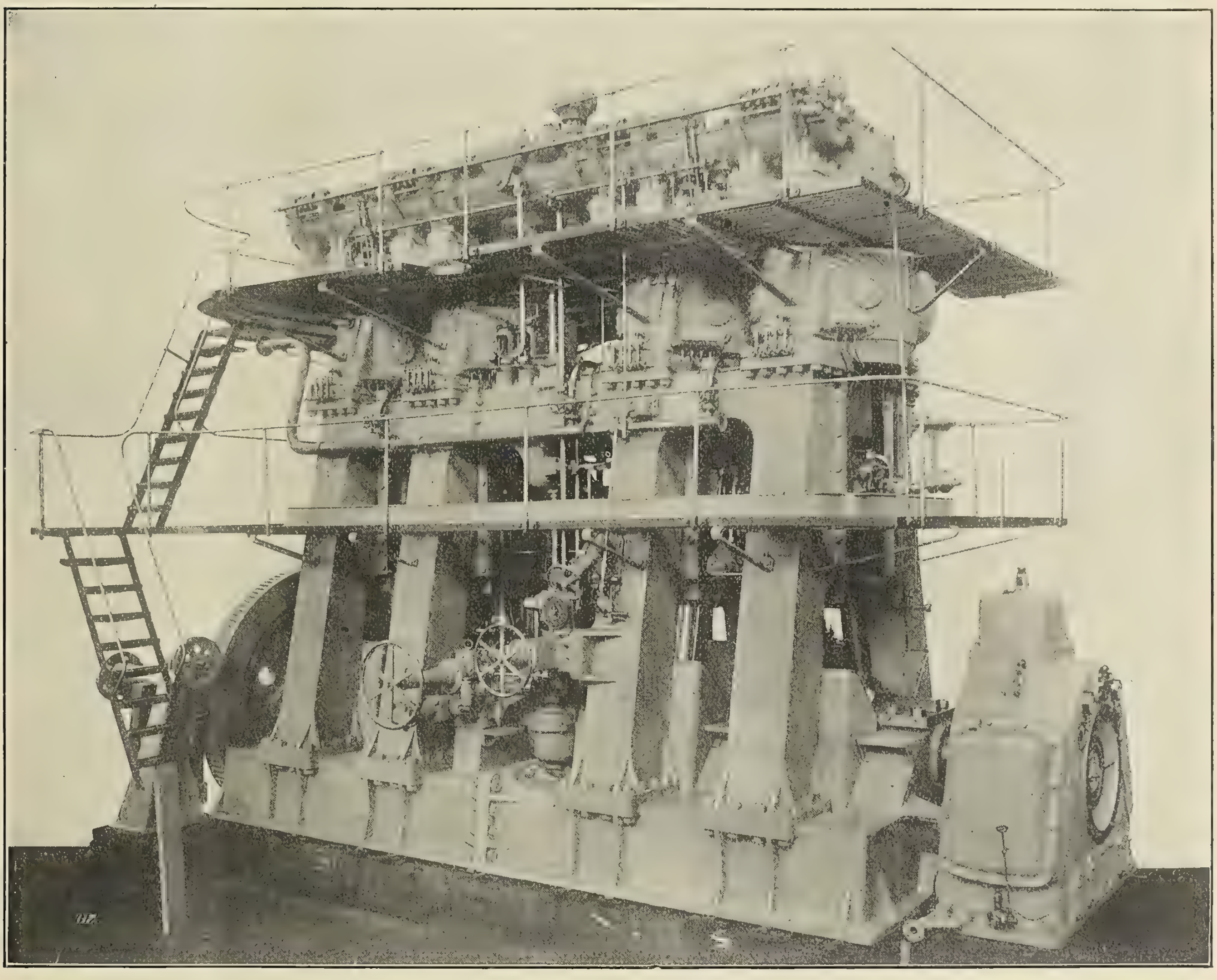


FIG. 1.—CARELS TWO-CYCLE DIESEL ENGINE FOR THE EAVESTONE

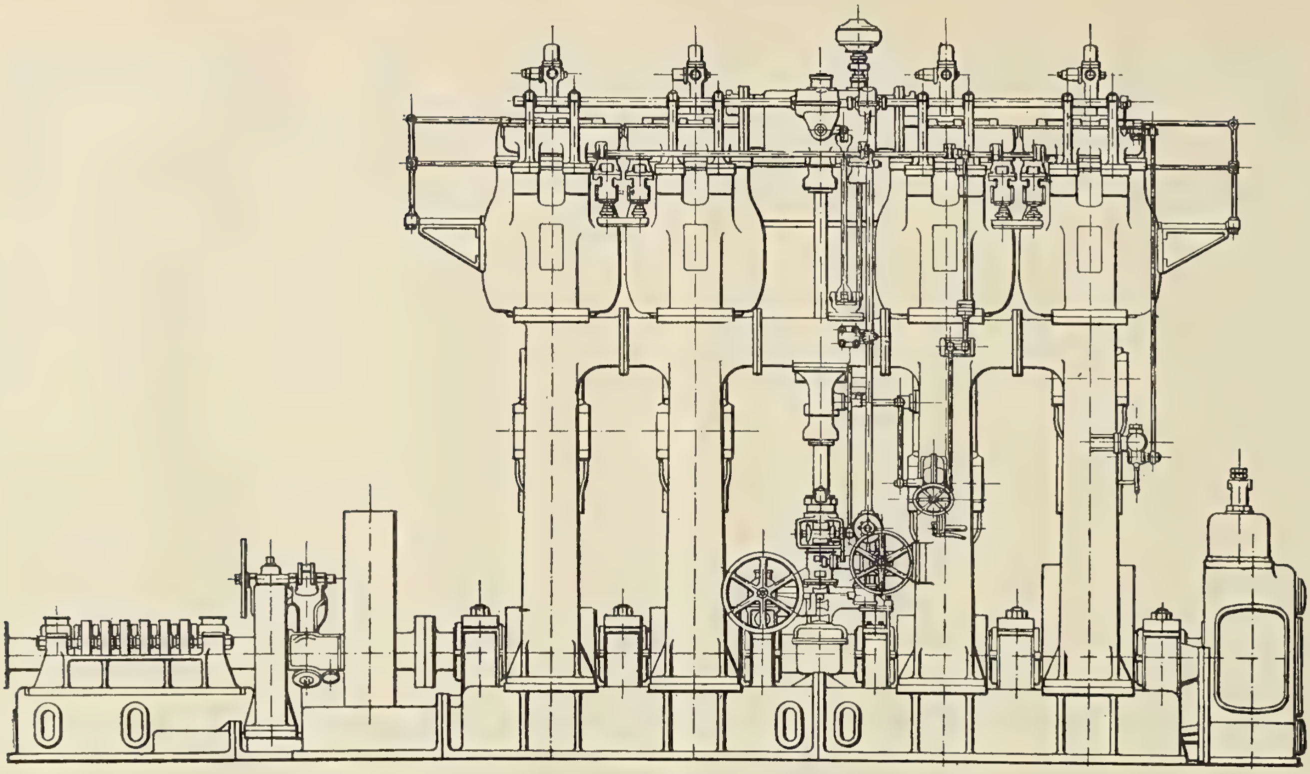


FIG. 2.—FRONT ELEVATION OF CARELS MARINE ENGINE

engines are of the four-cylinder, two-cycle type, with cylinders 20.1 inches diameter and 36.22 inches stroke. At 100 revolutions the total power developed is 1,000 horsepower.

The pistons, which are water cooled, are packed with spring rings of the Ramsbottom type, and work in a liner, which is a separate casting inserted into the outer jacket. At the lower end of the liner is a stuffing-box, which is fitted to prevent any leakage of exhaust gas past the piston into the room. A series of circumferential ports near the bottom of the liner form the exhaust ports, the scavenging and fuel valves are placed in the cylinder cover, all of which is thoroughly jacketed for cooling the cylinder head and the valves. There are four scavenging valves in each cylinder, and a fuel oil injection valve, together with an air-starting valve, is placed in the center of the cylinder head. All the valves are operated through levers actuated by cams carried on a shaft which is supported by bearings connected to the cylinder jackets. The cam-shaft itself is actuated by means of a valve shaft and spiral gear wheels at the center of the engine connecting the cam-shaft to the crankshaft.

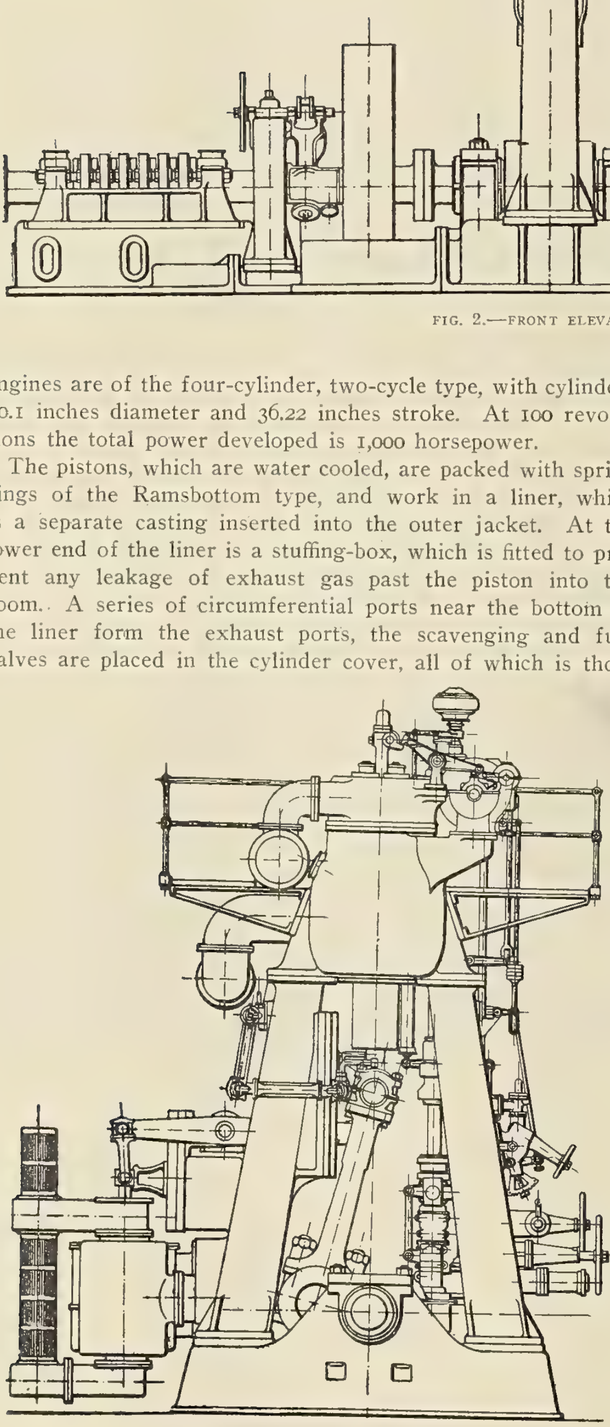


FIG. 3.—END ELEVATION

A fuel oil measuring pump is provided for each cylinder, and is driven from the cam-shaft. The amount of oil fed to the cylinders can be regulated by hand from the stationary platform, and an independent governor control is also provided. There are two sets of cams for the fuel injection and air-starting valves of each cylinder—one set being for ahead and the other set for astern operation. A maneuvering shaft, which runs alongside the cam-shaft, serves to operate the rollers of the valve levers, so that they are brought into contact with the proper cams for running the engine either ahead or astern. The maneuvering shaft is free to slide fore and aft in order to bring the rollers opposite the proper cams. A special motor is provided to change the position of the maneuvering shaft. At the same time the cam-shaft is rotated in order to change the position of the cams operating the scavenging valves in relation to the position of the crankshaft. This is accomplished by raising or lowering the vertical driving shaft by means of a special motor operating through a rack and pinion and connecting rod coupled to a lever secured to a sleeve on the vertical shaft. Both the motor for rotating the cam-shaft and that sliding the maneuvering shaft are operated by compressed air.

Compressed air at high-pressure for the fuel injection is supplied by a multiple-stage air compressor coupled to the forward end of the main crankshaft, while the compressed air for scavenging the cylinders at low-pressure is supplied by double-acting pumps driven by levers from the crosshead of the engine. Other pumps are also operated from the same levers, including the water circulating pumps and the bilge and sanitary pumps.

Lubrication is provided by gravity to all parts of the engine except the pistons, where a forced system is provided.

Complete control of the engine is brought to one point at the starting platform, from which the engine can be started, stopped and reversed in remarkably short time after the signals are received. The controls are so interlocked that it is impossible to operate them except in the proper sequence when starting, stopping or reversing the engine. The time required to reverse from full speed ahead to full speed astern on the trials of the *Eavestone* was found to be only eight seconds.

Since completion the *Eavestone* has been in continuous service. Her maiden voyage was from Sunderland to Antwerp with a cargo of coal. The voyage was made under splendid conditions, and those who were on board said that the engines were practically noiseless and that the cooling arrangements of the engines were very efficient. The maneuvering qualities of the engines also proved very effective when the vessel was handled in narrow waterways in port.

After discharging her cargo at Antwerp the *Eavestone* sailed to West Hartlepool, the voyage being accomplished in heavy weather, during which the engines showed their excellent reliability. It was found unnecessary in spite of the heavy weather to use the oil-regulating levers, and the engine's speed of from 87 to 96 revolutions per minute was maintained throughout the voyage.

At West Hartlepool another cargo of coal was taken on board for the Baltic ports, but before proceeding on the voyage a measured mile trial was carried out, on which the vessel easily made the contract speed of 9½ knots. This speed was made at 93 revolutions per minute, whereas the engines had been found capable of developing a speed of well over 100 revolutions per minute.

Some idea of the advantages gained by the use of Diesel engines in place of steam machinery in a vessel such as the *Eavestone* is shown by the fact that in the *Eavestone* there is an estimated saving in the weight of the machinery of 80 tons. Only 4 tons of fuel are used per day as compared with 15 tons per day for a steamer. The Diesel-engined ship would require 120 tons of fuel for a thirty-day trip, as against 450 tons for a steamer, showing a net saving of 330 tons for the Diesel-engined ship, which, in addition to the 80 tons saved in the weight of machinery, makes a net deadweight saving of of 410 tons in favor of the Diesel-engined ship. Additional savings would also be gained from the small bunker space required and in the reduction of the engine room staff.

Lumber and Passenger Steamer Columbia

The Harlan & Hollingsworth Corp., Wilmington, Del., completed on July 22 a steel lumber and passenger steamer for Wilson Bros. & Co., San Francisco, Cal.

The principal dimensions of the vessel are: Length over all 250 feet 11 inches, length between perpendiculars 243 feet 3 inches, beam, molded, 41 feet; depth, molded, 20 feet. The carrying capacity is 1,600,000 board feet of lumber at a load draft of 17 feet 6 inches. The gross tonnage is 1,923.84 and the net tonnage 1,188.

The vessel is built of steel, with one complete steel deck, a long poop and a forecastle deck. The scantlings are in excess of Lloyd's rules for ocean-going vessels.

The keel is of the flat keel type, 27½ pounds to 20 pounds at ends. The center girder, which is oil-tight for the whole length, divides the double bottom into two separate tanks and is 42 inches by 8 inches amidships. The double angle connections at the top and bottom are 4 inches by 4 inches by 12.8 pounds.

The side frames above the tanktop are 6 inches by 3½ inches by 3½ inches by 15-pound channels, spaced 24-inch centers. Belt frames, 6 frame spaces apart, are fitted throughout the length of the ship and are of 12 inches by 3 inches by 3 inches by 25-pound channels. In the peaks the frames are 5 inches by 3½ inches by 10.4-pound angles, 21-inch centers. The reverse frames are 3 inches by 3 inches by 7.2 pounds.

Two stringers run the length of the vessel under the main deck, consisting of 12 inches by 3 inches by 3 inches by 25-pound channels, fitted between each web frame and scored out for each ordinary frame. An angle 3 inches by 3 inches by 7.2 pounds runs inside of the ordinary frames on top of the channel. Diamond brackets are fitted on the face of the web frames connecting to the stringer channel. Between the main and forecastle decks the angle keelson inside the frames consists of double angles 5 inches by 3½ inches by 8.5 pounds.

The main deck beams are 10 inches by 3½ inches by 3½ inches by 21.8-pound channels on every frame, except where

STEAMSHIP COLUMBIA

no deck load will be carried. The brackets are 30 inches by 24 inches by 20 pounds with flanged edge. The camber is 10 inches in 41 feet.

To ensure a free cargo space only pillars along the center line have been fitted, composed of single H-bars 39 pounds per foot.

The shell is worked in "in and out" strakes with joggled edge landings of outer strakes. The garboard strake is 20 pounds and 18 pounds at the ends, the bottom plating 18 pounds and 16 pounds, the bilge plating 20 pounds and 16 pounds, side plating 20 pounds and 16 pounds, sheerstrake 25 pounds and 21 pounds, and the poop and forecastle 15 pounds. Below the waterline the plating aft maintains the amidships thickness.

The main deck plating is of 14 pounds throughout, except the stringer, which is 48 inches by 20 pounds to 16 pounds at the ends. The stringer angles are 4 inches by 4 inches by 12.8 pounds.

All watertight bulkheads are plated vertically with 13-pound plates, the stiffeners being 6 inches by 3 inches by 3 inches by 15-pound channels, spaced 30-inch centers and at the forepeak 24-inch centers. The brackets at the top and bottom are of 15-pound plates, connection to shell being by double 3½ inches by 3½ inches by 8.5-pound angles.

There are three longitudinals on each side of the keel in the double bottom, consisting of 13-pound intercostal plates flanged at the top and bottom, the floor connection being 3 inches by 3 inches by 6.1-pound clips. The intercostals in the engine and boiler rooms are of 16-pound plates.

The tanktop plating is 14 pounds throughout, except under the engine and boiler rooms, where it is 16 pounds.

The vessel has one triple-expansion, surface-condensing engine with cylinders 19 inches, 30 inches, 50 inches diameter by 36-inch stroke. The valve gear is of the Stephenson link motion type. The air pump, which is bolted to the back of the condenser, is worked from the crosshead of the intermediate cylinder. The electric generating plant consists of two sets of generators working at 115 volts, one of 15 kilowatts and the other of 7 kilowatts capacity, made by the General Electric Co. Each is driven by a single steam engine using 100 pounds steam pressure. An ice-making plant of one ton capacity per 24 hours, of the direct-expansion type, has been supplied by the Union Iron Works, San Francisco. There is also a 15-gallon water cooler. The two boilers of the cylindrical return-tube type, each 12 feet diameter by 11 feet 6 inches length, are constructed for 180 pounds working pressure. Each contains three furnaces 36 inches inside diameter, connected to one common combustion chamber. The tubes, 222 in number, are 3 inches diameter by 8 feet effective length. The oil-fuel burners are of Union Iron Works make, working with pressure, atomizing without steam or compressed air. One burner is fitted to each furnace.

The vessel has a Marconi wireless outfit and electric lighting throughout. A searchlight, 14 inches diameter, of the General Electric type, is installed on top of the pilot house, with inside control.

Four powerful hoisting engines, of Union Iron Works make, are mounted on special platforms.

There are four metallic life boats 23 feet long, also one 16-foot square stern working boat, all located on the bridge deck.

The main house, located on the poop deck, also the pilot house, officers' and after house on the boat deck, are built of pine, with sheathing tongued and grooved, and finished to resemble steel work. The boat deck has pine carlins 4 inches by 2¼ inches, spaced 24 inches, the decking consisting of 1⅛-inch tongued and grooved pine, with a margin strip around. Where exposed there is a double layer of felt on the deck, finished with canvas on top.

The dining saloon is paneled in white pine, as is also the lounge. The smoking room has walls stayed with "V" jointed tongued and grooved quartered oak. The total number of first-class passengers in staterooms is 54, of which the dining room can accommodate 36 at one sitting.

The vessel is equipped with two cast steel stockless anchors, of 3,500 pounds each; also one kedge anchor of 600 pounds.

There is a Hyde type brake windlass, with a double 8 inches by 8 inches engine on the forecastle. The steam steering gear is aft on the main deck; also alongside this is a 6 inches by 8 inches double engine operating a Hyde steam gipsy on the poop deck above. A No. 3 Providence automatic steam towing engine is located in a steel house on the poop deck aft. It has 14 inches by 14 inches cylinders and handles 1¾ inches diameter steel wire towing hawsers.

The vessel is schooner-rigged, carries a cross-yard and square sail on the foremast and the usual other sails. Each mast carries two wooden booms. Chain plates, turnbuckles and lashings of substantial design are supplied to secure a considerable deck cargo of lumber.

At the launch the vessel was named *Columbia,* her port of registry being San Francisco. On trial, with ballast tanks full, the vessel made a mean speed of 11 knots and developed 1,200 indicated horsepower. She is expected to make about 10 knots loaded in service.

The vessel, chartered by Bates & Cheseborough, sailed from Philadelphia with a full cargo in charge of Captain C. E. Allen. She is going out using oil fuel, and is expected to make a call at a South American port to refill her tanks with oil. The chief engineer is Mr. P. Concannon.

Two Notable Oil Engined Fishing Schooners

On the Pacific Coast of Canada, the long, narrow reaches of the inside route from Seattle and Vancouver to the halibut grounds off the coast of Alaska have made the sails of the fishing schooners employed in the halibut industry an almost useless part of their equipment during the major portion of their trips. To overcome this difficulty, many of these boats are equipped with auxiliary power; but it has remained with the New England Fish Company to take the longest step forward in the industry. This firm's headquarters are at Boston, but they have important offices in New York, Seattle, Vancouver and Ketchikan, Alaska.

They are now having built at the yards of Arthur D. Story, in Essex and Gloucester, Mass., two sister schooners of a modified knock-about type, 126 feet length over all; 102 feet length waterline; 24½ feet breadth waterline; with a mean draft of 10 feet, to be powered with two 100-horsepower Blanchard oil engines, operating twin screws and developing a speed under power alone of about 10½ miles an hour. They will have plain pole masts with no top masts, and the sail area will be cut down to 4,500 square feet, less than one-half that with which boats of this size would be normally equipped. Briefly, the sails are to be used only as auxiliaries to the engines, which are a late development by the Blanchard Machine Company, under the direction of Wolcott Remington. They are of particular interest in that they will use for fuel a low-grade, asphaltum-base oil that is put out by the Standard Oil Company on the Pacific Coast as Star Fuel Oil. It costs only a dollar (4/2) a barrel in Seattle, and its high-flash point makes it as safe as coal.

It is planned to launch the two schooners early in October; and, after the engines have been installed and the rigging and outfitting completed, they will proceed to Seattle via Cape Horn, arriving there in time for the early spring work.

The schooners were designed by Thos. F. McManus, of Boston. He has been prominently connected with the New England fishing industry for fourteen years, thirteen years as an active participant and the remainder as a designer of fishing schooners, and in that time has built and designed over three hundred vessels.

The original type of fishing schooner was shallow draft with long bowsprit and jib boom and very long main boom, giving it a long sail base line extending far outboard, making the work of handling sails in heavy weather exceedingly dangerous. In fact, the chance of wreck in storms was one of the most serious that fishermen of those days took; but now all this has been changed, and the production by Mr. McManus, several years ago, of the knock-about type, with its deep and sharp hull lines, short sail base and eliminated bowsprit, have made these boats safe and easy to handle in heavy seas. There is less pitching and great saving of wear and tear on the rigging; no bobstays to leak; no bowsprit to loosen; and, with practically no overboard work for the men to do in handling sails, they now fear only fog, collision and shore.

On the Pacific Coast the need for this step has been imperative, and the results achieved by these vessels will be watched with interest, not alone there, but on the Atlantic Coast as well, for the increasing need of power is being strongly felt by the Boston and Gloucester fishermen, as a delay of a few hours in landing their fish at T wharf may mean a decrease of hundreds of dollars in the prices they obtain for their catch.

The Bureau of Navigation reports 161 sailing, steam and unrigged vessels of 21,139 gross tons built in the United States and officially numbered during the month of August, 1912. Three of these, aggregating 10,101 gross tons, were steel steamships built on the Atlantic coast.

Fire Protection of Pier Sheds

BY SIDNEY G. KOON, M. M. E.

Probably the most terrible disaster on a pier or in a pier shed was that which, in 1900, destroyed the American terminal of the North German Lloyd Steamship Company in Hoboken, N. J. This fire started, probably by spontaneous combustion, in the midst of a pile of cotton bales on the unprotected pier, and swept like wildfire from one end of the great structure to the other, a distance of several hundred feet. Three transatlantic liners (*Bremen, Main* and *Saale*) were so badly damaged as to necessitate almost complete rebuilding, while the express steamer *Kaiser Wilhelm der Grosse* was badly scorched. About 300 lives were lost, mainly because of the extremely rapid spread of fire and the fact that the fire was between the crowd of passengers and employees and the shore, where safety lay.

For the use of transatlantic liners and other vessels, where it is necessary to handle large quantities of freight and baggage with dispatch, and where large numbers of people (passengers, crew and porters or stevedores) are moving back and forth, it is wholly impracticable to divide the space into relatively small compartments for the purpose of retarding the spread of fire which might start at any point. In the cases of the larger and more modern of these pier sheds we find a virtually unbroken area, measuring from 600 to 900 feet in length and from 100 to 130 feet in width. Small temporary wooden structures, such as shipping offices, etc., sometimes subdivide the area in slight measure, so far as general appearance goes; but as such structures are of the most combustible material, it is seen that from the fire protection standpoint they are of absolutely no avail. It is quite usual to find a ship on either side of this shed, both vessels engaged in loading and discharging miscellaneous cargo of the most heterogeneous type, and frequently of the most inflammable kind. The cotton bales mentioned in our opening paragraph indicate the truth of this last statement.

The problem thus becomes one of dealing with a situation, the salient features of which involve an enormous open space without fire breaks of any kind, and either a wooden, and hence combustible, construction of pier and shed, or where circumstances have made it imperative a fireproof pier and shed, filled more or less closely from one end to the other with inflammable material. The problem is further complicated by reason of the fact that numerous openings around the sides give free access to the more or less constant breezes to be found around the water, and which would inevitably help to fan into destructive size any incipient fire which might start.

The ordinary means adopted for fighting fires in pier sheds depends upon extinguishing, usually after the fire has gained considerable headway, by means of streams of water from nozzles connected to hose of varying size, some of it supplied with water pressure from the pumping outfits on the ships themselves, some from standpipe pressure on the pier, some from city fire departments, either with steam fire engine service or with high-pressure main service, while in the most favored cases a fourth source of stream is a fire-boat, now being so highly developed in cities where water commerce is a large factor in the life of the community. If any one of these could be directed at the seat of the disturbance within the first 60 or 90 seconds from the beginning of the fire, there would very rarely be anything sufficiently serious to call for newspaper comment. Usually, however, the efforts put forth during the first five minutes of the life of the blaze are almost valueless so far as well-directed operation is concerned. Excitement, lack of knowledge of location of apparatus or of methods of operating valves, and many other similar contributing features, make the problem most difficult. In this respect this sort of a fire is no different from any other, but these points are here brought out for the purpose of showing

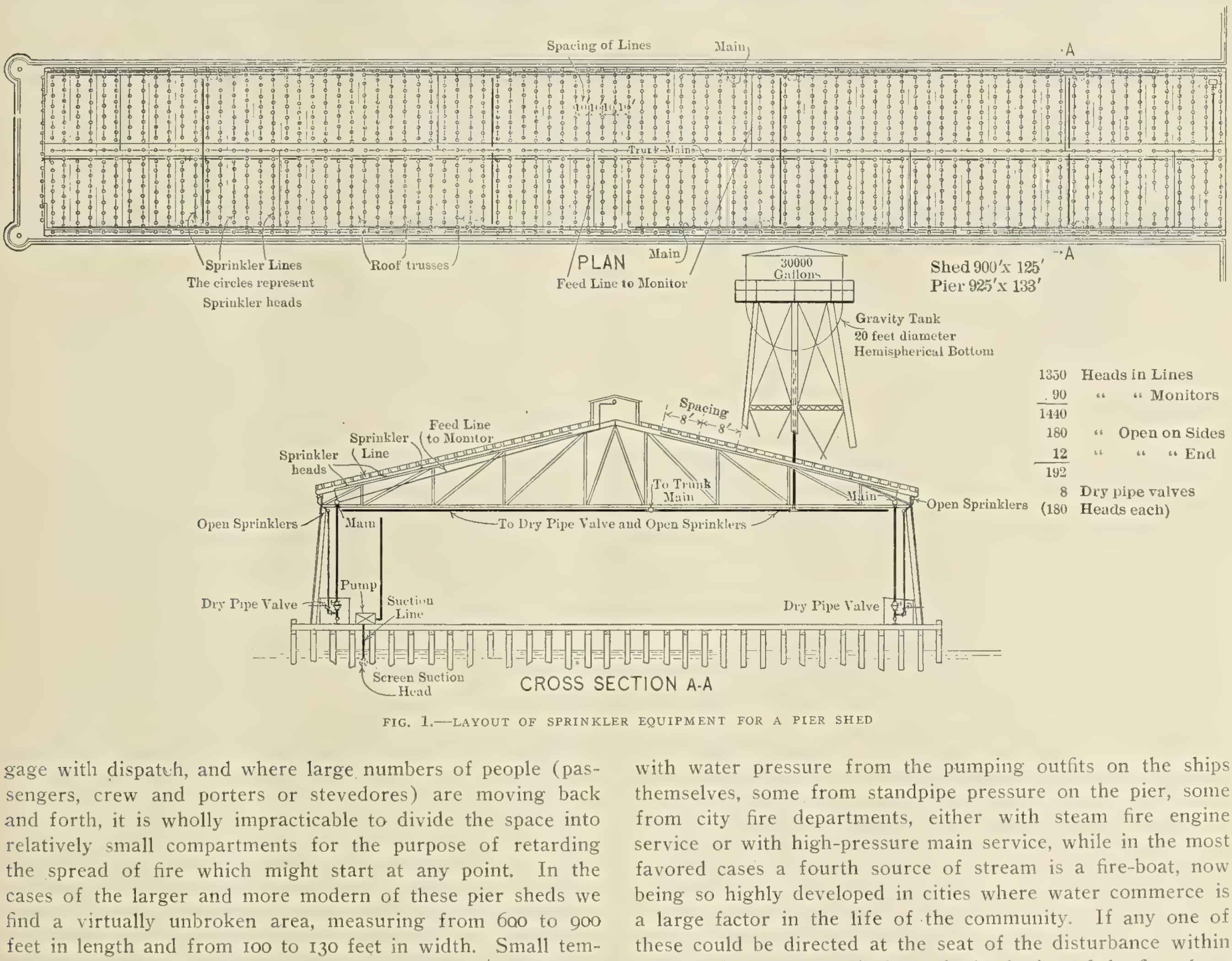


FIG. 1.—LAYOUT OF SPRINKLER EQUIPMENT FOR A PIER SHED

the contrast presented by automatic equipment of the type later described.

For the ordinary fire protection of buildings, whether manufacturing, mercantile, or office, numerous devices have been perfected and are on the market, practically all of which have value, but not by any means in equal degree. These include such items as automatic fire doors and shutters, closing when released by a fusible link whenever a fire raises a temperature above a certain predetermined point; standpipes with coils of hose attached; portable fire extinguishers depending usually upon the generation of some form of carbonic gas; and, most important of all, automatic sprinklers. The fire doors and shutters are analogous to wired glass windows in that they form a barrier acting to greatly retard the spread of fire. It is obvious that they would have no place on a pier shed, because it is impracticable to subdivide the space. The standpipe and hose and the portable extinguishers are already in use and have been responsible for putting out a great many fires. In both cases, however, it is necessary that men be at hand familiar with their use

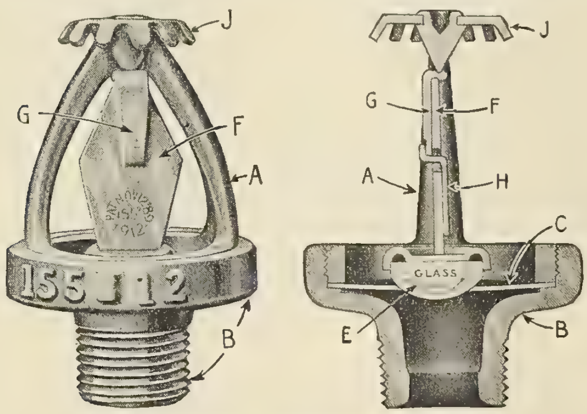


FIG. 2.—GRINNELL AUTOMATIC SPRINKLER HEAD

and able to direct the stream upon the fire before it has begun to attain destructive size. In case the fire occurs at night, it may gain very considerable headway before being discovered, and this sort of equipment will thus be completely nullified.

The automatic sprinkler, however, is a device which does not require the presence of any human being. It has through years of development been made so sensitive as to bring the proportion of failures down below one percent. It will operate under conditions of heat, smoke, darkness and other disturbing factors just as certainly and effectively as under the most favorable circumstances. Repeated tests have shown that sprinklers operate usually within thirty to sixty seconds of the first appearance of fire. Thirty percent of all fires under these sprinklers, as reported during the past fifteen years' experience by the National Fire Protection Association, have been put out or completely held in check by a single sprinkler head, while nearly 60 percent have been similarly controlled by not more than 3 heads.

For the ordinary fire hazard these sprinklers are arranged so that one head covers a floor area of from 80 to 100 square feet. The water supply is usually provided in duplicate, in order to make certain that at no time shall the system be without adequate water pressure and the building without protection. Where city water is available under good pressure this forms usually one of the dual sources. The other may be supplied by an elevated tank furnishing a pressure due to its static head; a pressure tank two-thirds full of water and one-third with air at considerable pressure, which will supply a moderate number of sprinklers for a few minutes; or an Underwriters' fire pump operated by either steam or electricity, and designed to deliver a maximum of from 500 to 1,500 gallons of water per minute.

The water is led into the building through a pipe large enough to supply a flow for the entire equipment. It is then carried in one or more risers up through the several floors, if there are more than one, and mains are taken off below the ceiling of each floor. In the case of the usual pier shed these mains would be taken off on each side and run parallel to side of shed, a little below the roof. From the mains are run branch lines, following the slope of the roof, each of which carries a series of sprinkler heads at intervals of about 8 feet, these lines being themselves about 10 feet apart. All of the piping is reduced gradually in size from the riser to the uttermost sprinkler, and it is all arranged with a slight drainage from that uttermost sprinkler back through the several subdivisions to the riser, in order that the system may be completely emptied of water when necessary. The sprinkler lines, parallel to the line of the roof and distant about 9 inches from it, carry the heads 4 or 5 inches below the roof and have natural drainage. In addition to the sprinklers throughout the open space, it would be necessary to provide sprinklers under the ceilings of all enclosed spaces, such as freight offices, waiting rooms, etc., the arrangement of lines and sprinkler heads being as before.

Each head consists of a pipe fitting, with a one-half inch opening for the passage of water. This opening is kept closed by a valve held rgidly in position by a strut, which is itself held together by fusible solder. The design of the strut is such that the physical strain upon it is well within its capacity. The solder is carefully prepared for a predetermined fusing point, usually about 155 degrees F. As soon as the temperature caused by the rising heat of the fire reaches this temperature at the location of the head, the solder fuses and the valve and strut are forced by the water pressure out into the room, leaving an unobstructed passage for a stream of water under full pressure. This stream, striking a deflector at the top of the head, is scattered in all directions in the form of a hard-driven rain. As all fires, except those from explosions, are very small at the start, it is evident that unless such a sprinkler equipment is handicapped by either obstruction to distribution of water, or in some other preventable way, a fire under the system is bound to be drowned automatically and very quickly. The action of the sprinkler in thus operating to put out the fire by means of the heat from the fire itself is such as to virtually make the fire commit suicide.

A typical and actual layout for a sprinkler equipment for this service is shown in sketches which, with the foregoing general explanation of the system, will be self-explanatory. One sketch shows the location of a fire pump upon the floor and of a tank on a tower upon the roof of the structure. Means would, of course, have to be taken to prevent this tank from freezing; this could be done either by a steam coil, or, in some cases, by an electric heater. In the same way, it would be necessary to either keep the temperature in the pier shed above 32 degrees F. or arrange for other means to prevent freezing up of the apparatus, and consequent nullification of its usefulness.

Highly developed apparatus for the purpose just mentioned takes the form of what is known as a dry-pipe valve, in which the water is held back in either the city main or the supply from the tank or fire pump. Eight dry-pipe valves, each controlling 180 sprinkler heads, were used in the layout illustrated. The sprinkler lines, mains and risers are filled with compressed air at a moderate pressure. The opening of a sprinkler head quickly releases this pressure. This at once operates the dry-pipe valve and allows the water which has been held back of this point to rush into the system, after which the operation is precisely the same as with the more ordinary wet-pipe system.

For protecting the outside of a shed, and material passing between the shed and the ship, open sprinkler heads are placed

along under the eaves at intervals of about 10 feet. These are not automatic. Water is turned into them whenever a fire threatens the outside of the shed, and as they are arranged in sections of about ten heads each along the length of the shed, it is obvious that protection may be extended just so far as may be necessary. In the open air the action of an automatic sprinkler at this point would be very uncertain because the heat of the fire would not in any way be confined, and it might get considerable headway before causing any action. That is why these outside sprinklers are controlled by hand.

While not going into the details of design, construction, and operation of a sprinkler system, it will be of interest to describe the head, upon the efficient, automatic working of which the value of the system depends. Two views of the head made and installed by the General Fire Extinguisher Co., Providence, R. I., are given, one being a section. As will be noted, *B* is the body or fitting which screws onto the tee in the line pipe. *A* is the yoke or frame carrying the deflector *J* and itself screwing into the body. Between *A* and *B* is a flexible diaphragm *C* with a half-inch hole in the center. Into this hole fits a hemispherical glass valve *E*. The valve is held in position by a small metal cap and a strut of three pieces, *F, G,* and *H*. The three pieces of the strut are joined by soft solder designed to fuse at 155 degrees F. As soon as the temperature reaches this point, the disruption of the strut begins, and ultimately takes the form of a rocking motion, one part about the other. During this movement, the flexible diaphragm, with the full water pressure under its entire area, holds tightly against the glass valve until as *F, G,* and *H* finally part, both the valve and strut are thrown out into the room and the solid stream of water, impinging upon the deflector, is scattered in all directions. After the sprinkler system has extinguished the fire, the one or more heads which have operated are removed from the system and new heads containing the strut in place are substituted. The water is then turned on again, and the system is ready for the next attack of its hated enemy.

Among the great advantages derived from the use of automatic sprinkler protection of this sort is a very large reduction in insurance premiums, amounting often to more than 50 percent. In the case of the ordinary building this reduction is sufficient to pay for the entire equipment within a period which averages about five years. When it comes to a question of pier sheds, however, the problem is considerably complicated by the fact that the piers are usually owned by the municipality and occupied by a tenant. The entire contents are owned by the tenant; but as the term of lease is ordinarily short, the tenant does not often feel justified in installing an equipment which would mean a considerable initial outlay, even though this outlay might be more than covered by his saving in insurance. For this reason very few piers have been fitted with automatic sprinklers, although a number of estimates have been made from time to time. In the case illustrated, the total cost of the installation was estimated at about $19,000 (£3,900).

Another great difficulty in connection with the fitting of these pier sheds arises from the question of water supplies. The sheds are so exposed, both inside and out, as to make freezing in the winter a matter of concern, and it is an engineering feat of considerable intricacy to arrange an equipment in this type of structure in which freezing will be adequately cared for. The thing can be done, however, and there is not the slightest possibility of doubt that the results would be thoroughly satisfactory and much more than justify the outlay. The financial loss sustained in the one fire which we have mentioned would have equipped all of the Hudson River piers of New York City with automatic sprinklers.

Panama Canal Act

The Panama Canal Act passed by Congress and signed by President Taft is a comprehensive measure providing adequately for the opening, maintenance, protection and operation of the Panama Canal and the sanitation and government of the Canal Zone. The act comprises eleven sections in all, only three of which, however, have direct bearing on marine affairs. These three deal with the Panama Canal tolls, the regulation of commerce, and the regulation of wireless communication, the provision of dry docks, repair shops, yards, docks, wharves, warehouses, storehouses and other necessary facilities for providing coal and other materials, labor, repairs and supplies for United States war vessels, and, incidentally, for supplying such facilities at a reasonable price for all shipping passing through the canal. The full text of these sections is as follows:

Section 5. That the President is hereby authorized to prescribe, and from time to time change, the tolls that shall be levied by the Government of the United States for the use of the Panama Canal: *Provided,* That no tolls, when prescribed as above, shall be changed, unless six months' notice thereof shall have been given by the President by proclamation. No tolls shall be levied upon vessels engaged in the coastwise trade of the United States. That section forty-one hundred and thirty-two of the Revised Statutes is hereby amended to read as follows:

"Section 4132. Vessels built within the United States and belonging wholly to citizens thereof, and vessels which may be captured in war by citizens of the United States and lawfully condemned as prize, or which may be adjudged to be forfeited for a breach of the laws of the United States, and seagoing vessels, whether of steam or sail, which have been certified by the Steamboat Inspection Service as safe to carry dry and perishable cargo, not more than five years old at the time they apply for registry, wherever built, which are to engage only in trade with foreign countries or with the Philippine Islands and the islands of Guam and Tutuila, being wholly owned by citizens of the United States or corporations organized and chartered under the laws of the United States, or of any State thereof, the president and managing directors of which shall be citizens of the United States, and no others, may be registered as directed in this title. Foreign-built vessels registered pursuant to this act shall not engage in the coastwise trade: *Provided,* That a foreign-built yacht, pleasure boat or vessel, not used or intended to be used for trade, admitted to American registry pursuant to this section, shall not be exempt from the collection of *ad valorem* duty provided in section thirty-seven of the act approved August fifth, nineteen hundred and nine, entitled 'An Act to provide revenue, equalize duties, and encourage the industries of the United States, and for other purposes.' That all materials of foreign production which may be necessary for the construction or repair of vessels built in the United States, and all such materials necessary for the building or repair of their machinery, and all articles necessary for their outfit and equipment may be imported into the United States free of duty under such regulations as the Secretary of the Treasury may prescribe: *Provided, further,* That such vessels so admitted under the provisions of this section may contract with the Postmaster-General, under the act of March third, eighteen hundred and ninety-one, entitled 'An act to provide for ocean mail service between the United States and foreign ports, and to promote commerce, so long as such vessels shall in all respects comply with the provisions and requirements of said act. Tolls may be based upon gross or net registered tonnage, displacement tonnage, or otherwise, and may be based on one form of tonnage, or otherwise, and may be based on one form of tonnage for warships and another for ships of commerce. The rate of tolls may be lower upon vessels in ballast than

upon vessels carrying passenger or cargo. When based upon net registered tonnage for ships of commerce the tolls shall not exceed one dollar and twenty-five cents per net registered ton, nor be less, other than for vessels of the United States and its citizens, than the estimated proportionate cost of the actual maintenance and operation of the Canal, subject, however, to the provisions of article nineteen of the convention between the United States and the Republic of Panama, entered into November eighteenth, nineteen hundred and three. If the tolls shall not be based upon net registered tonnage, they shall not exceed the equivalent of one dollar and twenty-five cents per net registered ton as nearly as the same may be determined, nor be less than the equivalent of seventy-five cents per net registered ton. The toll for each passenger shall not be more than one dollar and fifty cents. The President is authorized to make, and from time to time amend, regulations governing the operation of the Panama Canal, and the passage and control of vessels through the same or any part thereof, including the locks and approaches thereto, and all rules and regulations affecting pilots and pilotage in the Canal or the approaches thereto through the adjacent waters."

Such regulations shall provide for prompt adjustment by agreement and immediate payment of claims for damages which may arise from injury to vessels, cargo or passengers from the passing of vessels through the locks under the control of those operating them under such rules and regulations. In case of disagreement, suit may be brought in the District Court of the Canal Zone against the Governor of the Panama Canal. The hearing and disposition of such cases shall be expedited, and the judgment shall be immediately paid out of any moneys appropriated or allotted for Canal operation.

The President shall provide a method for the determination and adjustment of all claims arising out of personal injuries to employees thereafter occurring while directly engaged in actual work in connection with the construction, maintenance, operation or sanitation of the Canal or of the Panama Railroad, or of any auxiliary canals, locks, or other works necessary and convenient for the construction, maintenance, operation, or sanitation of the Canal, whether such injuries result in death or not, and prescribe a schedule of compensation therefor, and may revise and modify such method and schedule at any time; and such claims to the extent they shall be allowed on such adjustment, if allowed at all, shall be paid out of the moneys hereafter appropriated for that purpose or out of the funds of the Panama Railroad Company, if said company was responsible for said injury, as the case may require. And after such method and schedule shall be provided by the President the provisions of the act entitled "An Act granting to certain employees of the United States the right to receive from it compensation for injuries sustained in the course of their employment," approved May thirtieth, nineteen hundred and eight, and of the act entitled "An Act relating to injured employees on the Isthmian Canal," approved February twenty-fourth, nineteen hundred and nine, shall not apply to personal injuries thereafter received and claims for which are subject to determination and adjustment as provided in this section.

Section 6. That the President is authorized to cause to be erected, maintained and operated, subject to the International Convention and the Act of Congress to regulate radio communication, at suitable places along the Panama Canal and the coast adjacent to its two terminals, in connection with the operation of said Canal, such wireless telegraphic installations as he may deem necessary for the operation, maintenance, sanitation and protection of said Canal, and for other purposes. If it is found necessary to locate such installations upon territory of the Republic of Panama, the President is authorized to make such agreement with said Government as may be necessary, and also to provide for the acceptance and transmission, by said system, of all private and commercial messages, and those of the Government of Panama, on such terms and for such tolls as the President may prescribe: *Provided*, That the messages of the Government of the United States and the departments thereof, and the management of the Panama Canal, shall always be given precedence over all other messages. The President is also authorized, in his discretion, to enter into such operating agreements or leases with any private wireless company or companies as may best insure freedom from interference with the wireless telegraphic installations established by the United States. The President is also authorized to establish, maintain, and operate, through the Panama Railroad Company, or otherwise, dry docks, repair shops, yards, docks, wharves, warehouses, storehouses and other necessary facilities and appurtenances for the purpose of providing coal and other materials, labor, repairs and supplies for vessels of the Government of the United States, and, incidentally, for supplying such at reasonable prices to passing vessels, in accordance with appropriations hereby authorized to be made from time to time by Congress as a part of the maintenance and operation of the said Canal. Moneys received from the conduct of said business may be expended and reinvested for such purposes without being covered into the Treasury of the United States; and such moneys are hereby appropriated for such purposes, but all deposits of such funds shall be subject to the provisions of existing law relating to the deposit of other public funds of the United States, and any net profits accruing from such business shall annually be covered into the Treasury of the United States. Monthly reports of such receipts and expenditures shall be made to the President by the persons in charge, and annual reports shall be made to the Congress.

Section 11. That section five of the act to regulate commerce, approved February fourth, eighteen hundred and eighty-seven, as heretofore amended, is hereby amended by adding thereto a new paragraph at the end thereof, as follows:

"From and after the first day of July, nineteen hundred and fourteen, it shall be unlawful for any railroad company or other common carrier subject to the act to regulate commerce to own, lease, operate, control, or have any interest whatsoever (by stock ownership or otherwise, either directly, indirectly, through any holding company, or by stockholders or directors in common, or in any other manner) in any common carrier by water operated through the Panama Canal or elsewhere with which said railroad or other carrier aforesaid does or may compete for traffic, or any vessel carrying freight or passengers upon said water route or elsewhere; and in case of the violation of this provision each day in which such violation continues shall be deemed a separate offense."

Jurisdiction is hereby conferred on the Inter-State Commerce Commission to determine questions of fact as to the competition, or possibility of competition, after full hearing, on the application of any railroad company or other carrier. Such application may be filed for the purpose of determining whether any existing service is in violation of this section and pray for an order permitting the continuance of any vessel or vessels already in operation, or for the purpose of asking an order to install new service not in conflict with the provisions of this paragraph. The Commission may on its own motion or the application of any shipper institute proceedings to inquire into the operation of any vessel in use by any railroad or other carrier which has not applied to the Commission and had the question of competition or the possibility of competition determined as herein provided. In all such cases the order of said Commission shall be final. If the Inter-State Commerce Commission shall be of the opinion that any such existing specified service by water other than through the Panama Canal is being operated in the interest of the public, and is of

advantage to the convenience and commerce of the people, and that such extension will neither exclude, prevent, nor reduce competition on the route by water under consideration, the Inter-State Commerce Commission may, by order, extend the time during which such service by water may continue to be operated beyond July first, nineteen hundred and fourteen. In every case of such extension the rates, schedules and practices of such water carrier shall be filed with the Inter-State Commerce Commission, and shall be subject to the act to regulate commerce and all amendments thereto in the same manner and to the same extent as is the railroad or other common carrier controlling such water carrier or interested in any manner in its operation: *Provided*, Any application for extension under the terms of this provision filed with the Inter-State Commerce Commission prior to July first, nineteen hundred and fourteen, but for any reason not heard and disposed of before said date may be considered and granted thereafter.

No vessel permitted to engage in the coastwise or foreign trade of the United States shall be permitted to enter or pass through said Canal if such ship is owned, chartered, operated, or controlled by any person or company which is doing business in violation of the provisions of the act of Congress approved July second, eighteen hundred and ninety, entitled "An Act to protect trade and commerce against unlawful restraints and monopolies," or the provisions of sections seventy-three to seventy-seven, both inclusive, of an act approved August twenty-seventh, eighteen hundred and ninety-four, entitled "An Act to reduce taxation, to provide revenue for the Government, and for other purposes," or the provisions of any other act of Congress amending or supplementing the said act of July second, eighteen hundred and ninety, commonly known as the Sherman Anti-Trust Act, and amendments thereto, or said sections of the act of August twenty-seventh, eighteen hundred and ninety-four. The question of fact may be determined by the judgment of any court of the United States of competent jurisdiction in any cause pending before it to which the owners or operators of such ship are parties. Suit may be brought by any shipper or by the Attorney-General of the United States.

That section six of said act to regulate commerce, as heretofore amended, is hereby amended by adding a new paragraph at the end thereof, as follows:

"When property may be or is transported from point to point in the United States by rail and water through the Panama Canal or otherwise, the transportation being by a common carrier or carriers, and not entirely within the limits of a single State, the Inter-State Commerce Commission shall have jurisdiction of such transportation and of the carriers, both by rail and by water, which may or do engage in the same, in the following particulars, in addition to the jurisdiction given by the act to regulate commerce, as amended June eighteenth, nineteen hundred and ten:

"(*a*) To establish physical connection between the lines of the rail carrier and the dock of the water carrier by directing the rail carrier to make suitable connection between its line and a track or tracks which have been constructed from the dock to the limits of its right of way, or by directing either or both the rail and water carrier, individually or in connection with one another, to construct and connect with the lines of the rail carrier a spur track or tracks to the dock. This provision shall only apply where such connection is reasonably practicable, can be made with safety to the public, and where the amount of business to be handled is sufficient to justify the outlay.

"The Commission shall have full authority to determine the terms and conditions upon which these connecting tracks, when constructed, shall be operated, and it may, either in the construction or the operation of such tracks, determine what sum shall be paid to or by either carrier. The provisions of this paragraph shall extend to cases where the dock is owned by other parties than the carrier involved.

"(*b*) To establish through routes and maximum joint rates between and over such rail and water lines, and to determine all the terms and conditions under which such lines shall be operated in the handling of the traffic embraced.

"(*c*) To establish maximum proportional rates by rail to and from the ports to which the traffic is brought, or from which it is taken by the water carrier, and to determine to what traffic and in connection with what vessels and upon what terms and conditions such rates shall apply. By proportional rates are meant those which differ from the corresponding local rates to and from the port, and which apply only to traffic which has been brought to the port or is carried from the port by a common carrier by water.

"(*d*) If any rail carrier subject to the act to regulate commerce enters into arrangements with any water carrier operating from a port in the United States to a foreign country, through the Panama Canal or otherwise, for the handling of through business between interior points of the United States and such foreign country, the Inter-State Commerce Commission may require such railway to enter into similar arrangements with any or all other lines of steamships operating from said port to the same foreign country."

The orders of the Inter-State Commerce Commission relating to this section shall only be made upon formal complaint or in proceedings instituted by the Commission of its own motion and after full hearing. The orders provided for in the two amendments to the act to regulate commerce enacted in this section shall be served in the same manner and enforced by the same penalties and proceedings as are the orders of the Commission made under the provisions of section fifteen of the act to regulate commerce, as amended June eighteenth, nineteen hundred and ten, and they may be conditioned for the payment of any sum or the giving of security for the payment of any sum or the discharge of any obligation which may be required by the terms of said order.

Large Floating Docks

Owing to the recent departure of two large floating docks from shipyards at Barrow and Birkenhead for Montreal and Portsmouth respectively, there has been aroused a good deal of public interest in floating docks. There has, however, been some confusion as to the size of these docks, one of which has been described as being the largest in the world, which is not correct. The new floating dock at Portsmouth for the Admiralty is of just the same size and design as that built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., Wallsend, for the British Admiralty, and sent to the River Medway this summer. These twin floating docks, designed to lift battleships up to 32,000 tons displacement, are the largest yet built or owned in Great Britain, but still larger are the 40,000-ton floating dock owned by the German Government at Kiel and the 35,000-ton dock belonging to Messrs. Blohm & Voss at Hamburg.

Particulars of Some of the Largest Floating Docks in the World.

Dock.	Lifting Capacity. Tons.	Length. Ft.	Clear Width. Ft.	Depth Over Keel Blocks. Ft.	Owners.
Kiel	40,000	656	154	35¼	German Govt.
Hamburg	35,000	720	108½	33	Blohm & Voss.
Medway	32,000	680	113	36	British Admiralty
Portsmouth	32,000	680	113	36	British Admiralty
Montreal	25,000	600	100	27½	Can. Vickers, Ltd.
Hamburg	25,000	525¾	108½	33	Vulcan Co.
Pola	22,500	584¾	111½	37	Austro-Hung. Govt.
Rio de Janeiro	22,000	550	100	30	Brazilian Govt.
Hamburg	20,000	511¼	97	26	Reiherstieg Co.

FIG. 1.—MOTOR SHIP MONTE PENEDO

Sulzer Diesel-Engined Ship for New York-Rio Service

BY J. RENDELL WILSON

During the past two years we have repeatedly declared that the large motor ship has come to stay, and our statements have been borne out by the success of such Diesel craft as *Selandia, Christian X., Vulcanus, Toilei* and the numerous Russian vessels.

Quite a number of shipping concerns of repute have ordered Diesel craft, consequently the various marine engineers and shipbuilders in England and on the Continent have as much work of this nature as they can undertake. That the heavy oil engine is slowly ousting steam machinery from its proud position may be gathered from the fact that Messrs. Burmeister & Wain, builders of *Selandia* and *Christian X.,* have nine more large motor ships under construction to one steam vessel at their Copenhagen yards.

On Aug. 24 the trials took place at Hamburg of the Hamburg-South America Line's new motor ship *Monte Penedo,* a twin-screw vessel of 6,500 tons deadweight for the New York-Rio service. One of the most interesting features about her is that her Sulzer machinery is of the two-stroke type, so she is one of the first large ocean-going vessels to be driven by

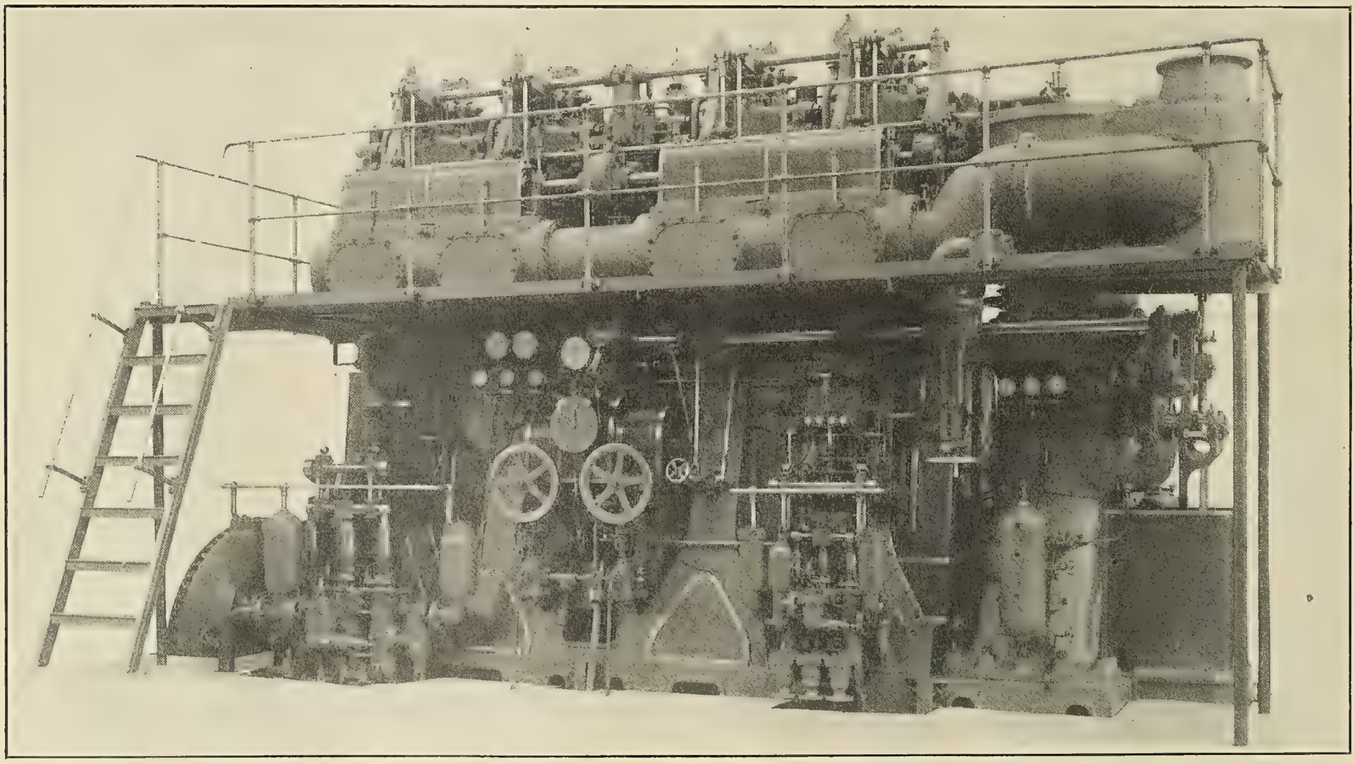


FIG. 2.—SULZER DIESEL ENGINE FOR THE MONTE PENEDO

this class of machinery, most all of the existing big motor craft having four-cycle Diesel engines installed. Thus her working will be closely followed by ship owners.

Monte Penedo is 350 feet in length by 50 feet beam, and has a molded depth of 27 feet. By dispensing with stokers there is a reduction in the engine-room staff of about ten men, or a net saving of nearly $3,500 (£710) per annum.

Compared with a similar steamship the cubic capacity of

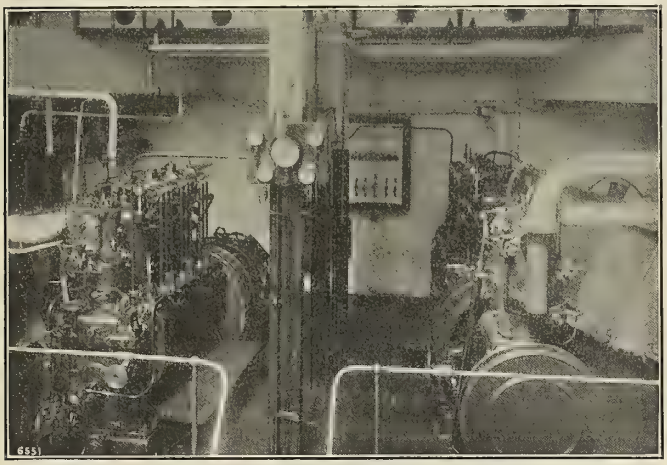


FIG. 3.—DYNAMO ROOM

fuel space is about one-fourth, so that a cargo gain of about 700 tons is effected, while owing to the small amount of room required by the engines an additional 200 tons of cargo space is gained, or 900 tons altogether.

Monte Penedo's engines weigh 150 tons complete, as against the 400-ton machinery of a similar size steamship. Thus the advantage of oil-engine power becomes apparent. Although designed for a loaded speed of 10½ knots this has been exceeded, while on trial a speed of 13½ knots was attained running light.

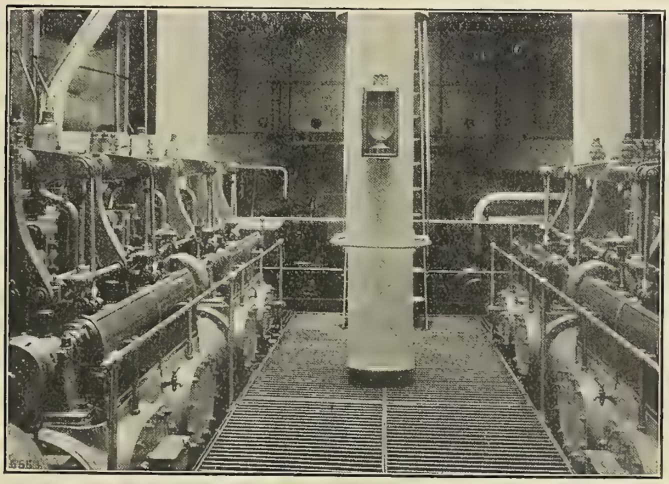


FIG. 4.—UPPER PLATFORM IN ENGINE ROOM

The machinery installation consists of twin Sulzer-Diesel engines for the propulsion of the ship and two smaller auxiliary Sulzer-Diesel engines, directly coupled to a dynamo and a compressor, respectively. Both the main engines are of the four-cylinder, single-acting type, working on the two-cycle principle, and at 160 revolutions per minute give 850 brake-horsepower, or a total of 1,700 brake-horsepower. (Cylinder diameter, 18.5 inches; stroke, 26.77 inches.) The bed plates are cast in three parts, and are of similar design to that of the marine steam engine. Naturally the cylinders covers are connected direct to the bed plates through steel columns, so that

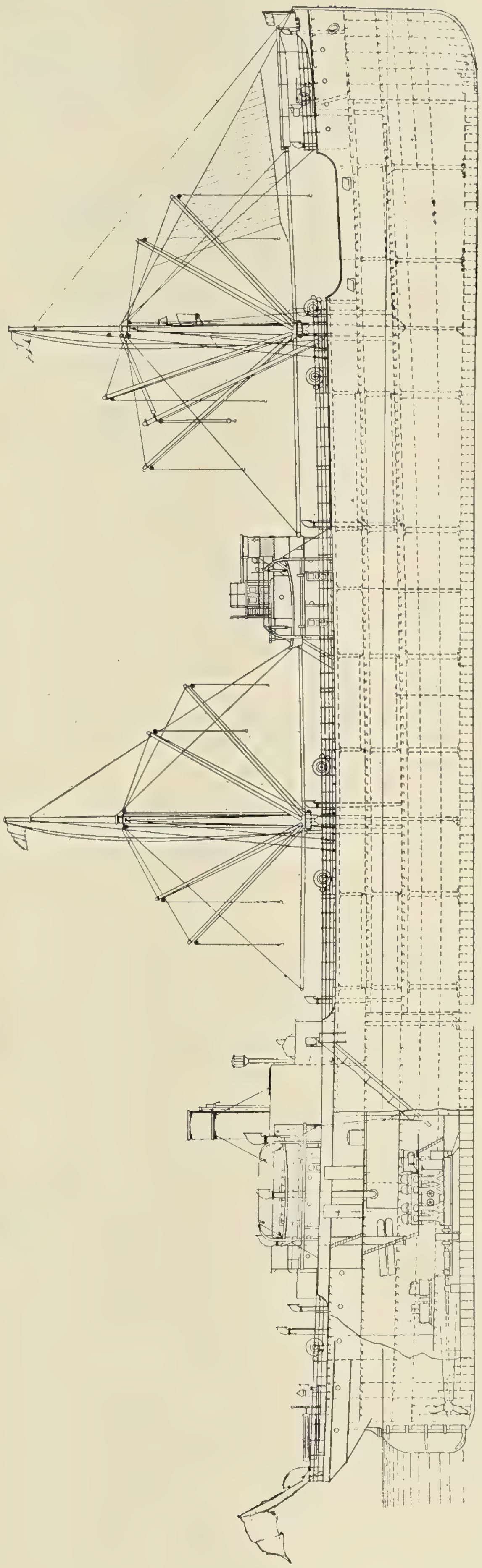


FIG. 5.—OUTBOARD PROFILE OF MONTE PENEDO

the explosive stresses are transmitted direct to the bed plate, leaving the body of the cylinders free from axial tensile stresses. This is very important where two-cycle engines are concerned, as the scavenging takes place through openings in the cylinder walls. In addition to the vertical steel columns cast iron columns are provided to take the transverse stresses and to provide guide surfaces for the crosshead shoes. The crossheads are provided with single-type guide shoes working on plates bolted to the columns, and the shoes are lined on their "ahead and astern" surfaces with white metal; the guide plates are adjustable and water-cooled. Planished steel plate doors enclose the engines, through which there is ample space for inspection and overhaul. Forced lubrication is provided for all working parts, the oil being cooled and filtered before being used a second time. A pump is fitted for the cylinder lubrication, the oil first passing through a sight-feed.

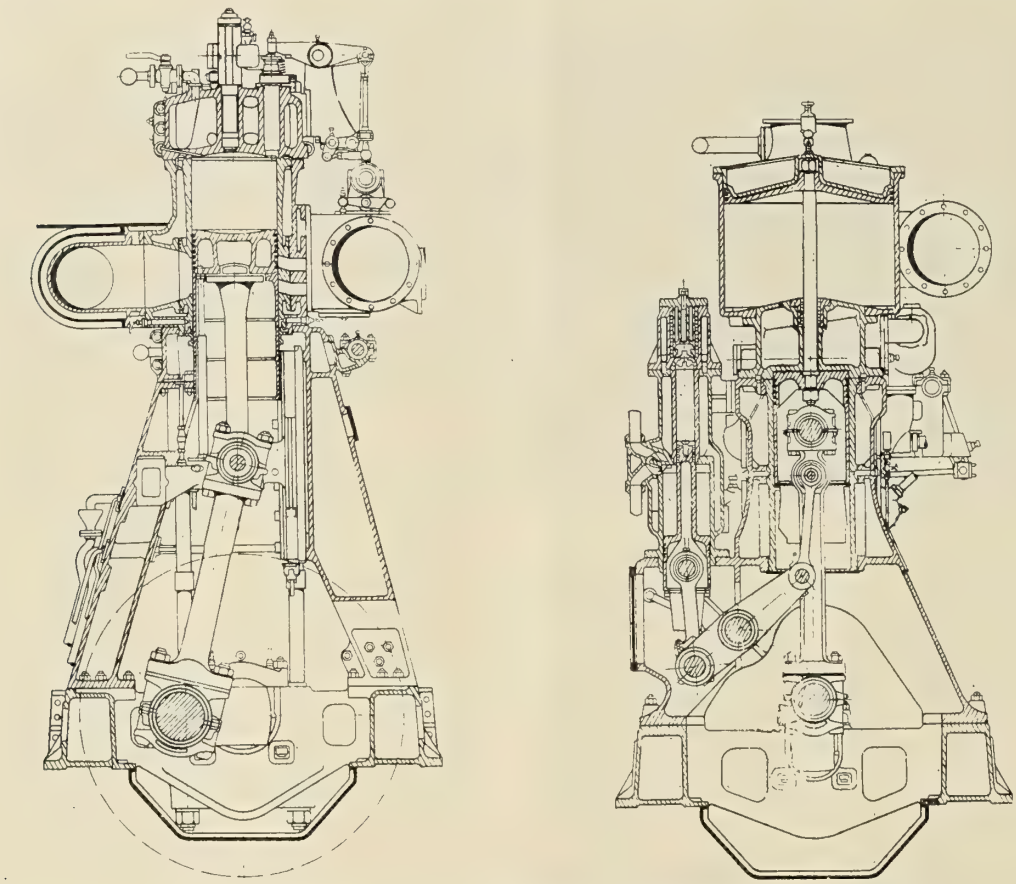


FIG. 6.—SECTIONS OF ENGINE THROUGH WORKING CYLINDER AND AIR COMPRESSOR

A most important and interesting feature is that the working pistons are water-cooled, and the water, led through telescopic pipes without stuffing-boxes, enters the piston head in the form of a free jet. All main cranks are set at 90 degrees, but the scavenging pump crank is set at an angle relative to the working cranks to give the best balance. The scavenging pumps are arranged on the forward ends of the crankshafts, and are controlled by a piston valve driven from the crankshaft through Stephenson link motion.

With regard to the compressors, these are of the three-stage type. The first stage serves as the crosshead of the scavenging pump, and the remaining two stages are driven from the crosshead through a patented system of balance levers. All three stages are water-cooled. Intermediate coolers are also provided, so that throughout the whole process of compression the air can be kept down to a suitable temperature. The compressor pumps are provided with automatic valves, so that no special reversing gear is required.

Scavenging air enters the cylinders through two horizontal rows of ports in the cylinder walls; the lower row is controlled by the piston alone, while the upper row is controlled by the scavenging valves and eventually covered by the piston. By means of this upper row air to any desired quantity may be introduced into the cylinder after the piston has closed the ordinary scavenging openings. The exhaust openings are arranged on the opposite side also in the cylinder walls. The exhaust gases enter a water-cooled exhaust pipe leading to a silencer, from which they escape freely into the atmosphere. This method of scavenging gives not only excellent results in working, but from the point of view of simplicity of design and safety is a decided advance on other existing methods, for should a scavenging valve fail it is impossible for a charge to escape into the exhaust pipe. The cylinder covers are very materially simplified and free from the otherwise customary multiplicity of valves and gear, for in consequence of this design there remain only the fuel and starting valves to be mounted on the covers. At the same time the reversing gear is also simplified, and thereby easy to operate.

The maneuvering gear consists of two mechanisms, each driven by a little compressed-air engine through a worm-drive. One engine serves to rotate the camshaft through the desired angle relative to the crankshaft, and to put over the scavenging pump connecting rods into the required position for ahead and astern running; the other serves to operate the fuel and starting air valve gear for starting, running or stopping. Maneuvering may also be done by hand gear, so that should the maneuvering engines fail through any cause whatsoever no time may be lost in carrying out the orders from the bridge.

As may be seen from the photographs these maneuvering engines are placed central on the front of the main engines, and so near to one another that if need be one engineer can

control both main engines. A governor is fitted, which on the slightest increase above the maximum speed operates direct on the fuel pump and cuts off the fuel.

The pumps for the various services are driven by means of balance levers from the crossheads of both No. 1 and No. 4 cylinders, and are constructed on the customary ship design. They supply cooling water for the working cylinders, pistons, compressor cylinders and inter-coolers, etc., and are connected for sanitary and bilge purposes. It must, however, be understood that the sanitary and bilge pumps were designed to be driven off the main engines at the special request of the ship owners, and in consequence the main engines appear somewhat complicated. A compresed air-turning engine is mounted at the back of each main engine, and drives through teeth machined on the periphery of the fly-wheel, which latter may be seen in the photographs.

We now come to the auxiliary machinery, which consists of two three-cylinder, single-acting Sulzer-Diesel motors of 8.07 inches bore by 8.66 inches stroke, working on the four-stroke principle. Both are of 50 brake-horsepower at their normal revolutions of 425 per minute. One is coupled direct to a dynamo, which serves for lighting the ship; the other drives a compressor for use in case of emergency or failure of the ordinary air supply, but especially for use when entering or leaving a port, canal or in similar circumstances when large quantities of air are required for maneuvering. The dynamo and its engine weigh 7 tons. The engine frames are built in two parts and of box form, strengthened internally by col-

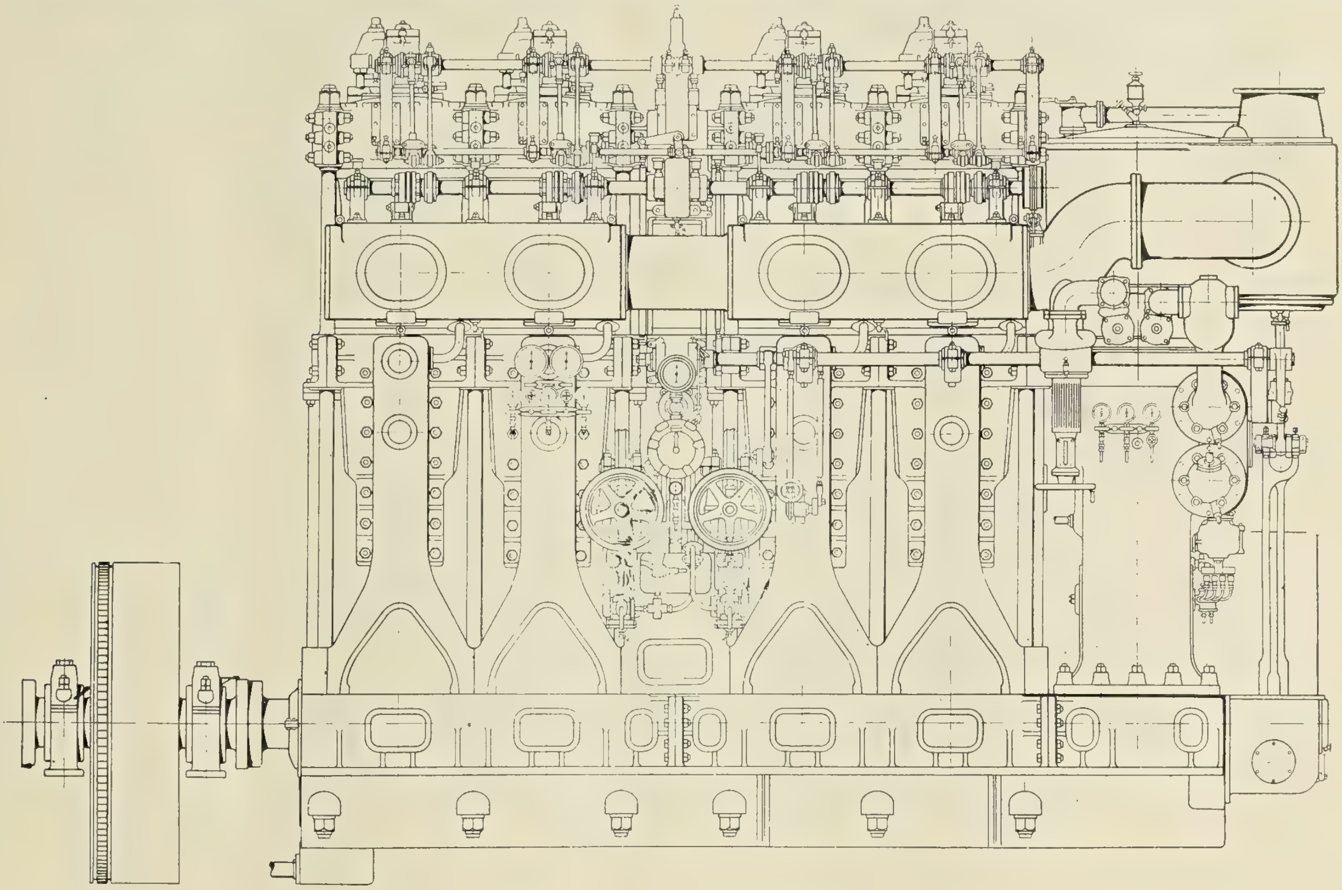


FIG. 7.—FRONT ELEVATION OF SULZER ENGINE

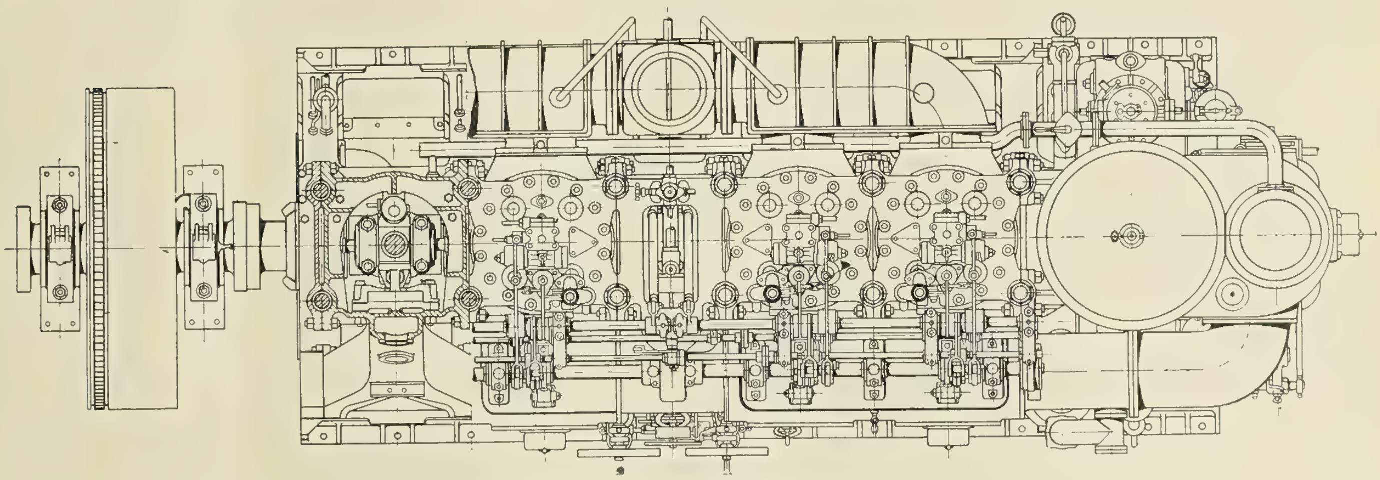


FIG. 8.—TOP VIEW OF SULZER ENGINE

umns, while the engines themselves are enclosed by light planished steel plates, easily dismountable for inspection or overhaul. On the cylinder heads the fuel, starting, admission and exhaust valves are mounted, and are operated through vertical rods by cams mounted on a horizontal shaft enclosed in the engine frame. This cam-shaft is driven from the crankshaft through spur gearing. The valves and valve gear are similar to the usual stationary four-stroke motor design. The fuel pump is driven direct by the crankshaft.

An adjustable governor is fitted, which works on the well-known principle of controlling the amount of lift of the suction valves of the fuel pump. An oil pump for cylinder lubrication is cast in one with the fuel pump, the drive being common to both. Forced lubrication is provided for all bearings and gudgeon pins by a pump placed inside the engine frame and which draws through a filter. The oil level can be read off a conveniently-placed gage. On the forward end of the auxiliary engines a semi-rotary wing pump, which is coupled to the crankshaft, supplies water for cylinder and compressor cooling.

The net weight of each main engine is 55 tons, or with all pipes, air flasks, exhaust, silencer, etc., 77 tons, while the air compressor and its driving motor weigh 6 tons, a total of 160 tons. The fuel consumption of each engine was proved on a forty-eight hours' run at normal working to be 0.46 pound per brake-horsepower-hour; but as the pumps for the various ship purposes are driven off the main engines the actual consumption is much lower, so the vessel will be very economical to work as far as fuel cost is concerned. The question of repairs can only be determined in time.

United States Naval Collier Orion: Built in Record Time

On March 23, just five months and seventeen days from the laying of the keel, the Maryland Steel Company, Sparrow's Point, Md., launched the new collier *Orion,* thereby establishing a new world's record for rapid ship construction. The vessel was completed in nine months and three days, the standardization trial taking place on July 9, off the Delaware Breakwater course.

She is one of two sister ships, the other being the *Jason,* now nearing completion at Sparrow's Point, and has an over all length of 536 feet, a length from the forward side of the stem to the after side of the rudder post of 514 feet, a molded beam of 65 feet and a molded depth of 39 feet 6 inches. The vessels are classed A-1 for twenty years under the American Bureau of Shipping and are built under the inspection of the Navy Department.

General Arrangement

The *Orion* is built on the Isherwood patent system of longitudinal construction, with the propelling machinery in the stern. The cargo is carried in six large holds, which are clear of stanchions, and by means of the topside tanks the coal is self-trimming. Five holds are fitted with two hatches each and the forward one with but one hatch. Forward of the cargo holds, under the lower deck, are four deep tanks for carrying cargo fuel oil. The inner bottom under the holds is also fitted for carrying cargo oil, and with the deep tanks has a combined capacity of 772,400 gallons. The topside tanks extend the length of the holds and are for water ballast only. The feed water is carried in the inner bottom under the engine and boiler rooms. The coal bunkers have a combined capacity of 2,248 tons and are fitted at each end and over the boiler room with a reserve bunker on the berth deck outboard of the engine room casing. The coal bunkers were designed with special attention towards eliminating trimming. A trimming tank is built between the after peak tank and after engine room bulkhead. Two domestic tanks of 20 tons total capacity are carried on lower deck aft of the engine room.

Coal-Handling Machinery

The contract requirement of handling 100 tons of coal out of each hatch per hour created such enormous stresses that a decided departure from the usual mast and booms was necessary, and the builders decided that the same design of coal-handling apparatus they developed for the collier *Neptune* would be satisfactory. The builders' wisdom in regarding this problem strictly as a coal-handling proposition, and not as a matter of appearance, was borne out when the operator handled over 137½ tons of coal per hour at the official test. This test took place at the Norfolk Navy Yard upon the completion of the 48-hour run, the operator raising the bucket to a specified height and distance outboard of the collier's side. The coaling booms are of a built-up type and are designed for handling continuously a working load of 7,500 pounds under service conditions. To handle all the buckets twenty-four Lidgerwood winches are installed, two of which are of special design, with double drums for operating the fore and aft trolley.

Deck Machinery

The deck machinery is composed of a Hyde steam pump brake windlass, with two gypsy heads fitted for warping and engines located on the deck below. A Hyde capstan is fitted aft on the poop deck, with cylinders enclosed in the base. The steering gear is the Hyde right and left screw gear type, fitted with three wheels of hard wood for hand steering and operated by a steam-steering engine controlled by a telemotor operated from the bridge.

Living Quarters

The crew of 152 men are carried 'tween decks forward and aft, and 25 officers are quartered in a deck house on the poop deck. The crew's quarters are finished in red cypress, the officers' and captain's quarters and dining saloon in white pine and white oak. The mess rooms and warrant officers' quarters are in white pine and red cypress. The bridge house is in red cypress and white oak. The trim in the galley, pantries and bakery is of ash. Screen doors and windows are fitted in the officers' quarters, with Venetian doors to the inside of all entrances to officers' quarters. Steel bulkheads are fitted around showers, water closets, pantries, galley, bakery and lavatories.

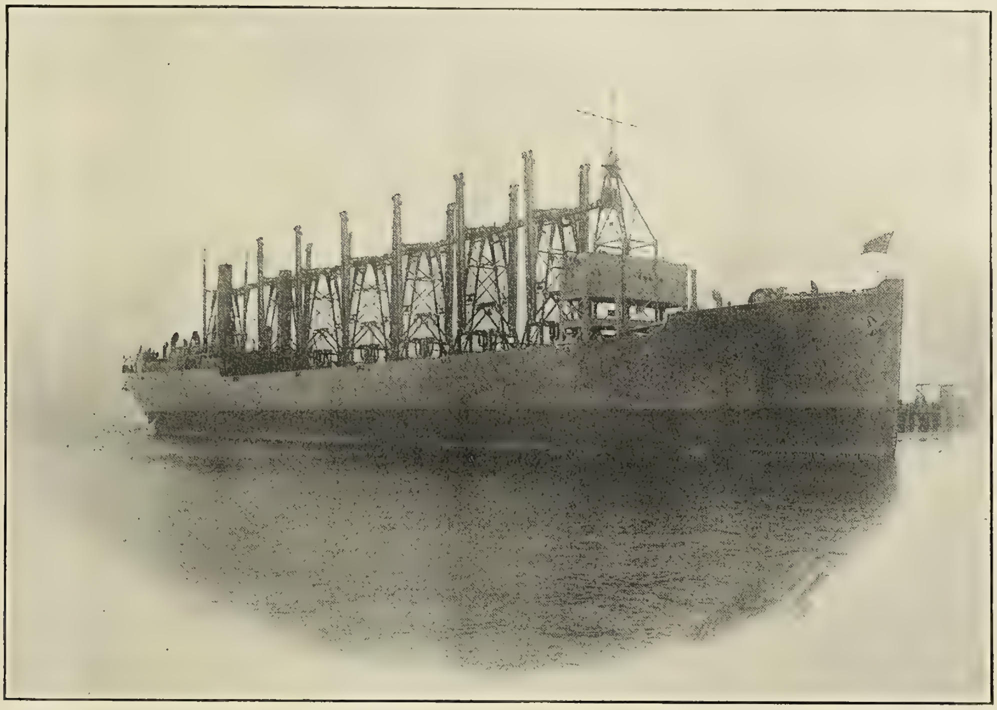
The floors of the galley, bakery and pantries are covered with a non-porous tile, the officers' lavatory with a white vitreous tile and the crew's lavatory with asphaltum cement. Linoleum is laid in the walking spaces of the crew's quarters and other necessary spaces and throughout in the petty officers' quarters, hospital and officers' quarters.

Fowler & Wolfe radiators are installed throughout the ship, with the system draining through a trap to a filter box or condenser. Two Sturtevant direct-connected generating sets of 25 kilowatts capacity are installed for lighting the vessel and operating a 24-inch searchlight. Inter-communicating telephones are installed in the captain's room, on the lower bridge, aft on the poop deck, in the chief engineer's room and in the engine room. The wireless apparatus has a radius of 200 miles.

Gain from Longitudinal Framing

A feature that was observed on the *Orion* was that the deflection due to the load was 71 percent less than that observed on the collier *Neptune* under similar conditions. The deflections taken for the above percentage were the maximum in both ships and were taken at the same point. The cargo on both ships at the time the deflection was read was 10,500 tons of coal, 2,000 tons of bunker coal, 120 tons of feed water and 130 tons of stores and crew.

Due to the saving in weight of the structure resulting from the use of the Isherwood system, the *Orion* carried the specified deadweight on a draft of 26 feet 10½ inches in place of 27 feet 7⅝ inches, as required by contract. This saving means an increase in deadweight of over 500 tons, or an additional earning capacity of 4 percent on the same initial cost and the same operating expense.



UNITED STATES NAVAL COLLIER ORION

Propelling Machinery

The propelling machinery of the *Orion* represents the highest class merchant type. The two main engines were designed with special reference to economy and are of the three-cylinder, triple-expansion type. The cylinders are 27 inches, 46 inches and 76 inches diameter by 48-inch stroke, designed for a working pressure of 200 pounds per square inch. All cylinders are fitted with piston valves. The crank shaft is 14¾ inches diameter, in two pieces. One main air pump, two bilge pumps and an oil pump for forced lubrication to the thrust block are direct connected to each main engine. The main condensers are independent of the main engine framing and are located just outboard of each main engine.

As the machinery is in the stern, there is only one length of line shaft. The propellers are of the three-bladed, built-up type, with cast steel hubs and manganese bronze blades. They are 16 feet 6 inches diameter and 18 feet mean pitch, and the trials of the *Orion* demonstrated that these wheels admirably suited the required conditions.

There are three double-end Scotch type boilers operating under the Howden's system of forced draft. Each boiler is 15 feet 10½ inches mean diameter by 21 feet 4 inches long and contains eight 40-inch inside diameter corrugated furnaces. The total heating surface is about 18,900 square feet. A donkey boiler 8 feet diameter by 10 feet 4 inches long, constructed for 200 pounds working pressure and located in the bunker between the engine and fire rooms, is provided for port use.

Auxiliary Machinery

The usual number of auxiliary machines have been provided, consisting of two 14-inch centrifugal circulating pumps, three long-stroke simplex feed pumps, a duplex fire pump, sanitary and fresh water pumps, two large evaporators with pump, two distillers with pump, an auxiliary condenser with attached pumps for port use, a pressure-type feedwater heater, two forced draft fans and a two-ton refrigerating plant. As the double bottom carries cargo, oil or ballast, there are two duplex pumps in engine room, cross connected to either service.

Trials

The 48-hour endurance trial run of the *Orion*, which was started July 10, proved very successful, the machinery running smoothly throughout, showing the following results:

Average for Forty-eight Hours

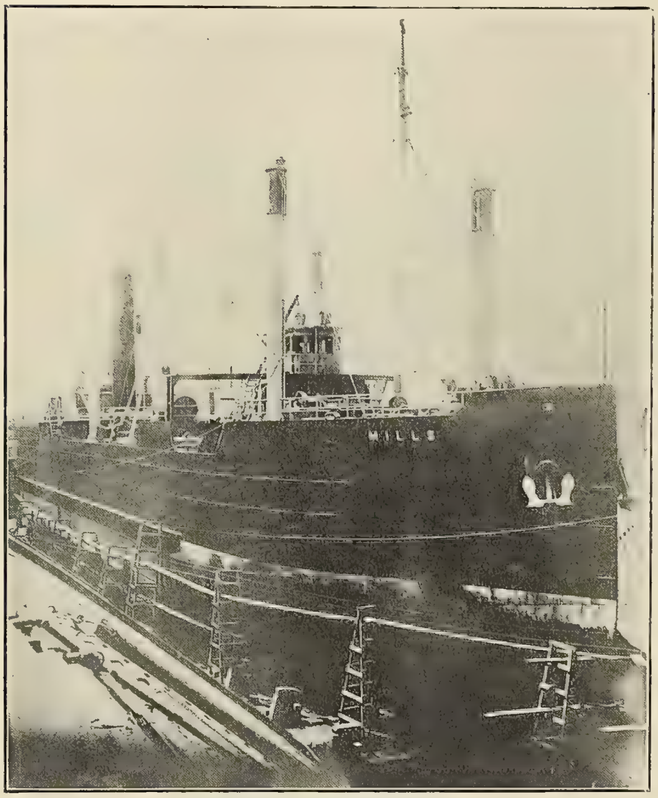
Revolutions per minute, average both engines..	95
Average steam pressure at boilers, pounds.....	195
Average steam pressure at engines, pounds....	192
Average air pressure in ash pit, water........	1 in.
Average I. H. P. both main engines...........	6,943
Average speed for run, knots................	14.468

The African steamer *Abosso* was launched recently by Messrs. Harland & Wolff, Ltd., Belfast, for the African Steamship Company, London (Messrs. Elder, Dempster & Company, Ltd., Liverpool, managers). The new vessel is 425 feet long between perpendiculars and 57 feet beam, with a gross tonnage of about 8,000. The propelling machinery, driving twin screws, consists of two sets of four-cylinder, quadruple-expansion balanced reciprocating engines, also constructed by the builders of the vessel.

The Steamship Mills—A Floating Fertilizer and Oil Factory

BY. C. B. EDWARDS

There are few ports which the fertilizer and oil-factory steamship *Mills* of Philadelphia makes which do not show great interest in the curious craft which captures millions of fish in a month and converts them into valuable products. Few indeed are the visitors allowed on board of this curious craft, and fewer yet are those who know that it is electricity which catches the fish, presses the oil out of them and grinds them up into fish scrap and fertilizer. Also it is this force which calls this craft to the fishing ground and summons other craft to take off the products when she is working at her full capacity, for, besides having all the machinery involved in the manufacture of fertilizer operated by electricity.



STEAMSHIP MILLS IN DRYDOCK

the *Mills* is provided with a powerful wireless plant. Nor is even this all that the electric plant on board of this unusual boat-factory does. In the busy season, which lasts from early spring into the late fall, the ship is at work all day and night taking in fish; and, to keep the work going at night as well as by day, arc lights and searchlights are called into use, which illuminate the ship so that the work is carried on uninterruptedly. There is some controversy as to whether the lights do not aid in attracting the fish to their destruction; but be that as it may, this boat, with its insatiable appetite for fish, never goes hungry from May till November, and brings back to her owners at the end of the season a million dollars' (£205,300) worth of products in oil and fertilizer.

The *Mills* is a ship of interesting history, and could she but relate her own experiences would tell a strange tale. A story of years of service, first as a suction dredge, later as a coastwise freighter, and finally as a fertilizer factory; for she had been converted from one calling to another three times now, and this promises to be her last if the profits she made for her owners during her first year of service as a fishing vessel is any criterion. To the casual onlooker she looks much like a torpedo-boat destroyer of the latest pattern, with many more than the required number of masts. These are the ventilating ports for the storage bins, through which electric blowers force the impure air from the inside. The *Mills* is not intended for speed and can make but slow progress, but for holding a large cargo she is unsurpassed. Some idea of the demands made upon the boat may be gained from the fact that she has to keep enough supplies on hand to feed her crew of 160 men for two weeks to a month at a time. She has to supply storage room for ten thousand barrels of food fish, and every day she converts the menhaden caught into eight hundred barrels of oil and twenty tons of fertilizer.

The *Mills* carries a complement of 160 men, divided into two shifts, one for day and the other for night work. When a school of menhaden fish is found, nets are slung over the side of the vessel and hauled in by electric hoists till the storage bins are full. Then the process of manufacture begins.

Screw conveyors, driven by motors, carry the fish into smaller receiving tanks and automatically feed them into steam cookers, and in a few minutes the fish are reduced to small particles. Then the cooked fish is forced through a rotary press to extract the oil, which is conveyed to testing tanks. Here, after it is found to be sweet and pure, it is cooled and allowed to flow into storage tanks of 2,000 barrels capacity. The fish scrap or fertilizer, from which all the oil has been extracted, is blown by an electric fan and dried as it is forced by the draft into other storage bins, where it is bagged as it arrives. This fish scrap is very inflammable, and the room in which it is stored is protected by an electric thermostat which notifies the commander in case of fire and allows it to be flooded at once.

As the menhaden are hauled up from the water by the nets, thousands of good food fish, such as bluefish, haddock and flatfish, are brought along with them. They are not good for oil and are worth a great deal for food, so they are sorted out by the workmen and placed in cold storage in a room which is electrically refrigerated by means of cold air and an ammonia cooling plant. Of course, it is not always possible for the boat to find schools of menhaden, and when they are not so plentiful smaller vessels are employed to do the fishing and bring them to the *Mills,* which acts only as a factory. The menhaden is an unusually prolific fish, though, and large schools are frequently discovered by smaller scouting vessels, which pass the word to the fertilizer ship by wireless, and she steams immediately to the scene of action. The fish look like herring, but are not edible, and when the *Mills* finished up her season last year she was fishing in a school off Nomans Land and extending to the South Shoal Lightship, a distance of eighty miles. The school was sixty miles wide.

When the storage tanks and bins are full, the wireless is called into use to summon barges and tugs to remove the cargo to the nearest shipping point. By this means a great deal of time is saved and the boat is always operated at its full capacity. While the *Mills* is an experiment, her first season last year netted her owners a handsome profit, and they express themselves as entirely satisfied; although it cost seven hundred thousand dollars (£143,600) to equip the boat with the electric and other apparatus necessary for her to carry on her work. The menhaden oil is an extremely useful material, essential in the tanning of leather, and recently a new use has been discovered for it in the mixing of paints.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Reliable Hand Wheels on Drain and Relief Valves

Most marine engineers have been annoyed at some time by the wooden hand wheels on drain and relief valves, sight-feed lubricators, etc., from their cracking and falling off on account of the heat, moisture and oil. On my job I have had all the wooden handles replaced with wheels made of red fiber, which have stood now for two years where wooden ones did not last a month. I have never seen any other hand wheels fixed in this manner, so this may be something new to many of the readers. Great Lakes.

Strange Noises

When going down the river on the trial trip of a small coaster peculiar sounds, which had escaped the ear of the man in charge, were noticed by the engine designer.

On going around the engines he had the impression that these emanated from the air pump, which was of the reciprocating type, directly connected to the main engine by the usual lever arrangement; it had Kinghorn disk valves for foot, bucket and delivery, with access door to each set, and a snifting valve on the suction branch.

Now, the designer's impressions were verified when on lifting the snifting valve a pronounced knock was heard; he also noticed that on the down stroke some water was squirted out, pointing to a suction valve remaining open. By this time the ship was on the mile course, and it was with reluctance that the shipbuilder, anxious to get through the trials quickly, agreed to stop. On removing the access door to the foot valves the cause of the trouble was exposed. A piece of waste having been left in one of the pipes had choked the valve. This removed, the door was replaced, and in ten minutes all was running sweetly. Engineer.

Dumbarton, N. B.

Fracture of a Rudder Head

While the steamship *M*—— was bound from New York to several ports in South America and steaming against a heavy and strong head sea, the rudder head fractured between the quadrant and the main deck through which the rudder post went. The fracture extended from one side of the head to the other, and took a vertical direction along the head for about two feet.

The ship was fitted with twin screws, so that we were in a way able to bring her head-on to the sea and prevent further damage; for if we had got broadside-on to that mountainous sea I think we would certainly have fared very badly, and perhaps with fatal results.

Well, we set to work, and the deck officers made several attempts to rig jury rudders, but each time the sea carried all away. The engineers then tried to help matters a bit by lashing the broken parts together with ¾-inch chain, but this was broken like twine. We then decided to try and utilize the spare cast steel bottom end, but, as it was too long to go between the bearing and the quadrant head, one side check of each brass had to be cut off. This was done by our drilling twenty-two ¾-inch holes around the flange and splitting it off with a drift pin. The bottom ends were then tried in place, but as the rudder post was only 10 inches in diameter and the crank pin was 13½ inches diameter, we found it necessary to use packing. This was done by wrapping the ¾-inch chain that broke around the fracture several times, and then securing the whole with the bottom end, which was bolted together with the spare top-end bolts; these being shorter and less in diameter, were easily fitted. It took us eighteen hours to complete the repair, and I must say it made a thoroughly sound job, enabling the ship to weather an exceptionally heavy storm for twenty-four hours after the repair was completed. Nothing of any note happened for the remainder of the voyage, and when we struck the first port thorough repairs were completed. F. J. S. N.

Another Word as to the Use of Graphite in Boilers

Since the publication of my letter in the July issue of your magazine I have received several letters from various brother engineers, asking the kind of graphite I found best suited for removing scale and preventing corrosion in steam boilers.

Now I should like to caution my brother engineers against some of the cheap grades of graphite that are now being offered on the market for cleaning boilers and preventing scale formation. These inferior grades cannot with safety be introduced into steam boilers. In the first place graphite of this kind is too impure, containing as a usual thing from 20 to 50 percent graphite carbon. The impurities consist of clay, silicate, etc., which means that for every 100 pounds used there would go into the boiler from 50 to 80 pounds of scale-forming substance, which, together with the impurities naturally carried in the feed-water, would be too much for the 20 to 50 pounds of graphite carbon to handle.

Then, again, these cheap grades are only coarsely ground, whereas graphite to do the work which it should do in a boiler should be so impalpably fine that it will remain suspended in the water of a boiler in operation, and in circulating through it prevent by its mechanical action the formation of hard scale so difficult to remove.

I have found that amorphous graphite will give the best results, both for lubricating purposes and for removing and preventing scale formation. Flake graphite will not do the work as well as the amorphous will. The graphite mined in Mexico I have found from experience to be the best for steam boilers.

I hope that my letters will be the means of helping a good many of my brother engineers to get away from hard scale troubles, and without the use of strong chemicals.

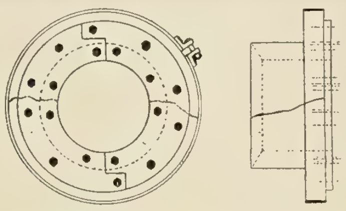
Norwich, Conn. W. V. Ford.

The Repair of a Broken Stern Gland

There is a fine old Latin proverb which compresses a lot of marine engineering truth into the two words *festina lente*, which being interpreted means that there is no use in getting excited. Very often it pays a man to spare the time necessary to get out his pouch and fill his pipe before setting in to put things right which appear to be going to the dickens. There are cases, of course, where prompt action is the only way to save the ship, but there are other occasions when the cautious attitude of a dog tackling a hedgehog has to be observed. The matter in hand has to be looked at up and down, and likewise crosswise before anything is done.

This sermonette is prompted by a busy time which the engineers on board one vessel had, owing to the undue strenuousness in putting things right to start with. The original cause of the trouble was that a junior engineer had been told off to tighten up the stern gland a little. He had done it more than a little and had not set it properly. The result was that the gland warmed up beautifully, and when the trouble was discovered the ship's bacon could have been done to a turn upon it. Unfortunately the engineer who discovered the mess was of an energetic nature. He turned on a cock on the aft-peak ballast tank bulkhead, which let a stream of cold sea water onto the stern gland. The sudden contraction was too much for it and it broke as indicated in the sketches.

Of course there are other and more gradual ways of cooling off an overheated bit of metal, and the engineer would probably have thought of them if he had given himself time. It



SKETCH OF REPAIRS TO BROKEN STERN GLAND

may be interesting, however, to describe how the trouble was got over. The engines, of course, had to be stopped, and the way the repair was carried out is also indicated in the sketches. A band was first made out of a strip of ¼-inch plate, long enough to go round the circumference of the gland flange, and at its ends there were riveted two lugs of stout cross-section, as shown in the sketch. Through holes in these lugs a ⅞-inch bolt was passed, and when this had been tightened up the bolt gripped the flange of the gland and drew the broken parts tightly together. When this was done a piece of boiler plate ½ inch thick was taken and pieces cut out of it of the shapes shown in the sketch, so that the two fitted fairly accurately together and encircled the shaft. The division between them was, of course, necessary in order to get the plate over the shaft. These pieces of plate were then held in place on the gland, and ⅝-inch tapping holes were drilled through the plate and into the flange. When these were tapped and ⅝-inch tap bolts were screwed in, the two broken halves were secured firmly together, and the repair held for two and a half months without any trouble before it was feasible to get a new gland put in. All the same, *festina lente* is a very good motto.

J. J. M.

A Curious Marine Mishap

When the American steamship *Virginian* and the British tramp steamer *Strathalbyn* collided off Three Tree Point, half-way between Seattle and Tacoma, one night last winter, it resulted in one of the most serious marine mishaps on Puget Sound in years. While only one life was lost the damage to the two big steamships approximates $100,000 (£20,500). The *Strathalbyn* was repaired at the plant of the British Columbia Marine Railways, Esquimalt, B. C., while the *Virginian* went into service again after repairing in Seattle at the plant of the Seattle Construction & Drydock Company.

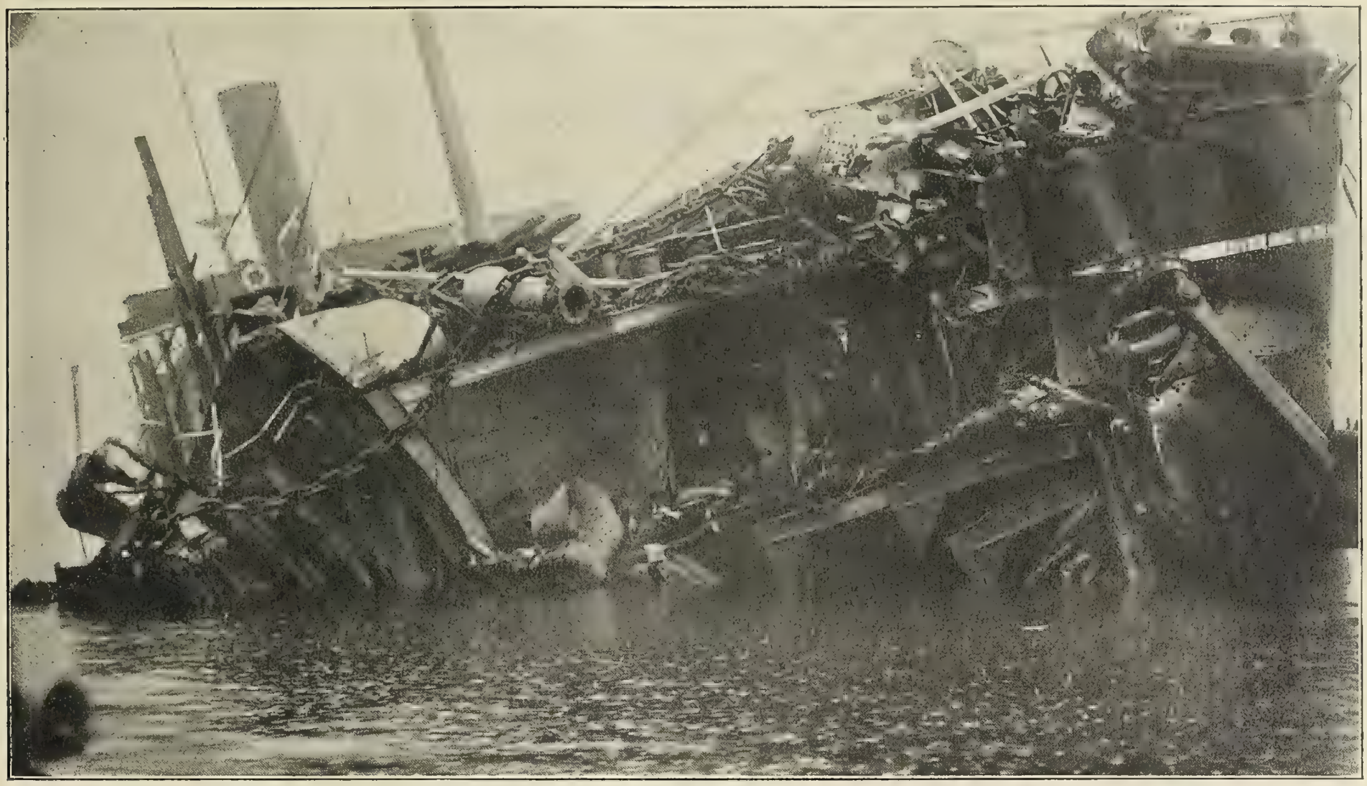
The *Virginian*, 5,077 net tons, of the American-Hawaiian Steamship Company, was proceeding to Tacoma to complete loading for the Hawaiian Islands. The *Strathalbyn*, 3,602 net tons, of the "Strath" fleet, owned by William Burrell & Son, of Glasgow, was bound from Tacoma to sea with 3,500,000 feet of lumber for Sydney. Both vessels were in charge of licensed pilots. At the time of the accident, which occurred at about 8 o'clock, the night was dark but clear, with a light rain not sufficient to obscure the vision.

The testimony of the officers of the two steamers conflicted in important details. The burden of the story of those on the *Strathalbyn* was to the effect that the British steamer blew one whistle for passing port to port. At that time both the red and green side lights on the *Virginian* were visible. Receiving no answer from the American vessel, the *Strathalbyn* again blew one whistle, no response being made. By this time the *Virginian's* red light disappeared. Then the *Strathalbyn's* helm was ported and her engines stopped. One minute later the *Strathalbyn* again gave one whistle for the *Virginian* to pass her to port, the *Virginian*, whose green light only was visible, again failing, it is claimed, to answer. Then the British tramp backed full speed astern, sounding several blasts in quick succession as a danger signal. Three blasts came from the *Virginian* in response thereto.

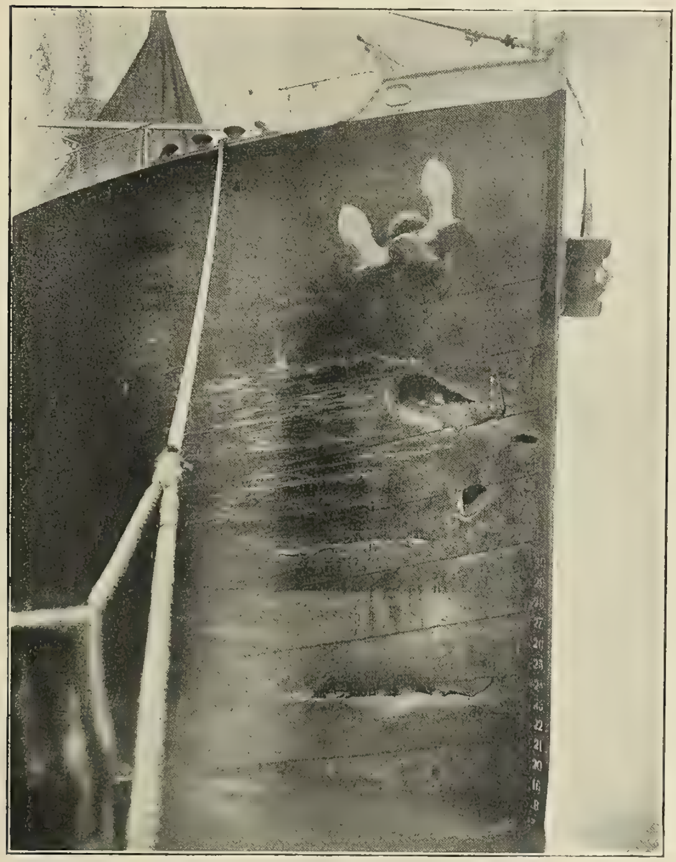
On the other hand, officers of the *Virginian* state emphatically that they saw no lights on the *Strathalbyn* until the latter hove in sight, and it was too late to avoid the collision. Passengers and officers on local seamers which passed the freighters a short time before the mishap testified that they saw the *Strathalbyn's* lights, but added that they were dim. The master and officers of the *Strathalbyn* admitted that the steamer's electric light plant went out of commission just prior to leaving Tacoma, but they claim that oil range and side lights were substituted sufficient for all purposes. Sifting the entire testimony, which is conflicting in the extreme, there seems to be no clear reason for the mishap, and it is likely that the resulting libel cases from both parties will be in the courts for adjudication for a line time.

Notwithstanding the severe injuries to both vessels, the masters refused assistance and both proceeded to Tacoma, where the *Virginian* arrived three hours later and the *Strathalbyn*, seriously crippled and with No. 1 hold filled with water, stem almost submerged and a heavy list to starboard, five hours after the mishap. The *Virginian* was not badly injured, and at Tacoma continued to work cargo. The *Strathalbyn* made fast to a buoy, but the next morning she began taking water at such an alarming rate that she was beached on the flats, where, as shown in the accompanying photograph, she appears like a total wreck. The lumber cargo was discharged from No. 1 and No. 2 holds, the water pumped out, and when the vessel righted it was seen that the damage did not extend below the water line. In this condition she steamed from Tacoma to the Esquimalt dock at Victoria, B. C. It was found that when lying at the buoy with a serious list water was pouring below through the ventilators, making beaching necessary.

In the accompanying photographs is told an interesting story of the mishap. Incidentally they show how much more seriously the British steamer was damaged, testifying to the better material in and construction of the American vessel. Striking the *Strathalbyn* on the latter's port bow, the imprint of the British tramp's port anchor is easily seen on the starboard bow of the *Virginian*. The *Strathalbyn's* stem was twisted many feet to starboard, and in the photograph her port anchor is seen about where the starboard anchor should be. On the starboard side of the *Strathalbyn* the forecastle was completely torn away, the plates being crumpled up for a distance of 10 feet below the main deck aft to 8 or 10 feet into No. 1 hold. The wreckage hung overboard on the starboard side for 8 or 10 feet beyond the side of the vessel. In this mass of crumpled plates the body of the one victim of the mishap was found. Until the wreckage was cleared away he was thought to have been washed overboard. When the *Strathalbyn* left Tacoma, this wreckage, weighing about 20 tons, was released and dropped into deep water. The photograph also shows how the forecastle was laid open and how the starboard anchor and chain were pushed aft to almost abreast of the foremast. The photograph was taken while the



WRECK OF THE STRATHALBYN



DAMAGED BOW OF THE VIRGINIAN

Strathalbyn lay beached in Tacoma harbor, and she was the most curious spectacle of a marine mishap seen hereabouts in many years. Repairs are estimated to cost about $60,000 (£12,300).

For repairing the *Virginian* the specifications called for removing the stem from the upper deck to the first scarf, fairing and returning; renewing six plates on the port side, removing and fairing two; five new plates on the starboard bow, four to remove and fair and one to repair and fair in place; on the port side two frames to fair in place, and on the starboard side three frames to renew and six to fair and replace. The two breast hooks were also faired. There was some damage below the waterline extending into the fuel oil tank in the forepeak. The injury on the starboard side included a rip about 12 feet long and 10 to 12 inches in width above the oil tank. Above this, four plates were found punctured on starboard side. On the port side one plate was punctured and others bent. Compared with the *Strathalbyn* the *Virginian* fared very well. The *Virginian* was repaired by the Seattle Construction & Drydock Company, time allowed being eighteen days. The contract included docking at Puget Sound Navy Yard, as no other dock on Puget Sound could accommodate the vessel. At first the owners figured on making only temporary repairs here, later docking and repairing permanently at San Francisco. However, the local firm made an atractive offer and all the work was done here.

The local board of United States Steamboat Inspectors, after hearing considerable testimony in this case, have reached the conclusion that they have no jurisdiction. On Puget Sound pilotage is not compulsory for vessels under registry, and pilots operating in these waters on vessels under registry are subject only to State officials. As a result the entire matter will be decided in the courts, the Federal inspectors having decided to take no action whatever.

Seattle, Wash. R. C. Hill.

An Effect of Galvanic Action

Marine engineers are too often absorbed by the routine of their daily duties to bear in mind the more extraordinary causes of breakdown, but occasionally occurrences come round which remind them that one cannot be safe without keeping one's wits and eyes about. It is, of course, a well-known fact

that dissimilar metals have a galvanic action upon one another, especially in the presence of a good conductor of electricity, such as salt water. If these two metals are in contact with one another and exposed to sea water, local electric currents are set up which eat up the material from which the electric "cell" is formed. The same thing is sometimes taken advantage of in boilers in order to direct corrosion from the boiler plates and tubes to some material that does not matter so much when a block of zinc is hung from one of the stays and dipping in the boiler water. The zinc becomes eaten away instead of the iron.

Sometimes, however, this action is not in favor of but against safety, and designers of vessels must occasionally forget about it, or else an incident such as the one about to be described would not have taken place. On one occasion, while a ship was under steam, one of the boilers was being blown down, when, without any warning, the blow-down cock on the ship's side fell down out of its place, and there was a heavy inrush of sea water. The boiler was, of course, at once shut off, and the stream of incoming water into the stokehold was stopped for the time being by hammering a plug of soft wood into the ship's side.

The trouble was as indicated in the first illustration. The spigot on the blow-down cock casting, which was of brass, passed through the ship's side in order to carry the water over

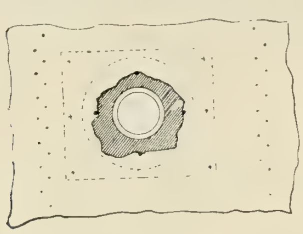


FIG. 1

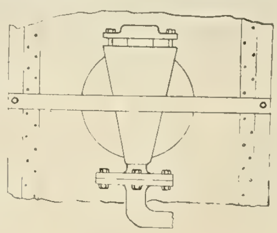


FIG. 2

the plate. Owing to the contact of the steel of the plate with the brass of the spigot in the presence of sea water a galvanic action had been set up which had the effect of corroding the ship's side. This, of course, could not be seen, and so was undetected until the corrosion had eaten its way so much towards the bolt holes securing the flange of the cock to the side of the ship that the plate was too weak to stand and the cock fell away. The area of corrosion is shown shaded in the sketch.

The way in which a temporary repair was effected, sufficiently good to keep the cock in commission till the vessel reached the home port, can best be understood from the second illustration, which shows a view of the repair from the inside of the ship. A strong iron band was made out of ¾-inch iron, long enough to pass from one of the ship's side frames to the other across the location of the opening, and shaped so that when tightened up it would bear on the cock so as to press its flange against the unbroken portion of the plate. A rubber insertion joint was then cut suitably to make a water-tight joint between the flange on the blow-down valve and the sound portion of the plate. The wooden plug was taken out again and the cock was put in place with the insertion joint in position, the iron band was then put on and screwed tightly in place, and finally the disused bolt holes, which, of course, were letting water through freely all the time the repair was being effected, were plugged up with wood.

This, of course, could not be regarded as a permanent repair, and on arrival at the home port, where full engineering facilities were available, a ½-inch covering plate made of brass was fixed to the outside of the ship's side, as shown dotted in the first figure, and the blow-down cock was secured to this by means of bolts passing through the holes in the flange. This effected a permanent job which was satisfactory.

J. B. Brooks.

Total Breakdown of High-Pressure Engine

The steamship *B*——— broke down while at sea on a voyage from London to Constantinople with a general cargo. She was towed into the nearest port, which happened to be Cherbourg, in France.

Upon the surveying engineer examining the engines, it was found that the forward one was shored up from the keelson by means of spars cut for the purpose, and shored sideways to the bunkers and vessel's side. This we had to do to prevent the cylinders coming down bodily after the accident, owing to the cutting away of all forward support (which I will endeavor to explain later on) and the rolling of the vessel.

Upon further examining the machinery it was seen that the accident was due to the fracture of the connecting rod bolt in the bottom end of the rod, and the fracture extended for about three-quarters of the entire length of the bolt. This fracturing of the one bottom end bolt had the effect of shearing the fellow bolt close up to the nut end. The metal of the bolt which fractured showed itself to have been very reedy, and that only about one-half of its area was available for work. This flaw may have existed from the first and yet not be visible on the surface.

Owing to the fracture of these bolts the piston, with its rod and the connections of the forward engine, had made a violent stroke upwards which broke several of the studs securing the cylinder head and started them all. The steam by this time had been admitted on the top side of the piston, causing it to make a down-stroke with greater violence still, the result being that the foot of the connecting rod struck the starboard cast iron column of the forward engine, completely severing it at the foot, and displacing it to the extent of about 6 inches. It was also cracked half round just below the surface of the slipper, and it had also started on the top at the foot of the cylinder, the bolts next the center line of the engine being broken.

While the connecting rod was in the position mentioned the crank of its engine was brought round by the after engine, and struck the rod just above its foot, bending the latter in two directions, and also bending the piston rod cross-head in one of the bolt holes. This caused the slippers (or shoes) to be immovably jammed between the guides, the tendency of the cross-head being to force the guides apart. This no doubt caused in some measure the displacement of the starboard column and the fracture in five places of the port or condenser columns.

It was impossible to send the vessel home without effecting temporary repairs; but the question was where to get any shop assistance, the only establishment approaching an engineer's workshop being what we would call out here a blacksmith's shop. This shop contained five fires, two small lathes, a drilling machine and a steam hammer. When we set eyes on the latter tool we entertained great hopes, as wrought iron was the only material for such a repair. But to our dismay we found the firm had not enough steam at their command to use the hammer. Castings could not be obtained except from a great distance, but then there were no pattern makers, consequently inquiries were made concerning getting work done by the navy yard authorities, but they would give us no assistance unless a private firm could not be obtained to undertake the work, and that private firm had to make a declaration to that effect. This the firm declined to do. It was remarked that it would take them three months to do the work. Their answer was that that was possible, but that they would "do it in time," and would make no declaration of inability. Consequently we had to make the best of the appliances at our command, and the ship's firemen were turned into machinists, work which they did most willingly, and

worked night and day, making use of the little workshop to the best advantage.

We commenced to disconnect the disabled engine, and it was with the greatest difficulty that the connecting rod could be disengaged from its position, the withdrawal of the guide plates jammed by the bent cross-head being an operation of great difficulty with the appliances at hand. However, after nearly three days' work the connecting rod and guide plates were got out. The cylinder head was next lifted out, with a view to drawing the piston and removing the piston rod in order to straighten it. We got two disused dredger links, and we used them together with two 1½-inch screw plates and nuts to draw off the piston from the rod, but found it to be immovable, at the same time using a 4-cwt. steel ram, worked by ten men, to strike the end of the piston Finding that this failed we built a charcoal fire around the piston eye, which we kept going without any successful result. We next tried sulphuric acid around the cone of the piston rod for several hours, and then the ram was again used for some hours, but still the rod would not start.

It was then decided to break off the tail end of the piston rod, which works through the cylinder head; we did this, and the fracture then showing it to have been half broken through already. The only plan left was either to split the piston or drill out the piston rod, both serious questions, the one method entailing a casting, the other the welding on a new cone and screw to a piston rod 4¾ inches in diameter at a common smith's fire and by hand, this weld having to stand the whole stress of one engine. It was ultimately decided to adopt the latter method.

After this had been accomplished it required several blows with the heavy ram to start the rod. On examination it was found that the piston rod had been driven ¾ inch over the cone and into the piston, and yet the piston had not split.

Having got the piston, piston rod and connecting rod out, ready for heating and straightening, the cylinders were then lifted by means of shores and wedges, and endeavors were made to wedge the broken columns back into place. This having been done, and some small pieces of ¾-inch boiler plate having been found in a store yard, the patches were begun. The one on the starboard column foot was supplemented with a plate inside. The plates had to be worked hot to place, and were secured by 1-inch bolts and nuts, the holes being drilled and tapped.

It was in the meantime that we decided to support the engine by means of wrought iron ties and struts, leaving the broken columns the duty of supporting the guide bars only. We then procured some lifeboat davits, 3 inches diameter, from the navy yard, as used on the warships. These were used to construct the ties and struts which were already in place.

Our next job was to straighten the piston rod; it was got fairly true and quite sound. We next had to weld a new end on the piston rod, and I am glad to say that this was done in a most satisfactory manner. The piston rod had then to be turned up, when, upon examining the finished collar, it was found to be cracked half-way round its circumference. We could not procure a new rod for a long time, perhaps for weeks, so we set about another plan. A hole 2¼ inches diameter by 8 inches deep was drilled through cross-head and up into the piston rod, and into this was screwed a 2¼-inch fine threaded steel screw, and in addition we had forged, bored and shrunk on a wrought iron clip, which was again secured to cross-heads by means of two turned bolts.

The connecting rod was in the meantime got approximately true, and the connecting rod keep having been straightened as well as the cross-head bolts. The reconnection of the engines was then proceeded with, and we had considerable difficulty in getting all fair, having to use a pair of old and nearly wornout connecting rod brasses instead of a pair of new ones in store. This made the connecting rod bolts ¾ inch too long, which necessitated the making of a new wrought iron keep.

Well, after a bunch of hard work we got the engines together again, and everything being coupled up and finished, steam was got up and the engines started and kept running for twelve hours. No signs of springing, heating or weakness having developed the vessel proceeded on her voyage. The engines drove the vessel from Cherbourg (France) to London at an average speed of 6 knots without mishap or stoppage.

Upon our arrival in port, and on an examination being made, it was found that the temporary repairs had stood well, there being no signs of failure or weakness in any of the many patches or stays. The machinery, however, had been so strained that it was necessary to completely dismantle the engines, consequently the cylinders and their connections, pistons, piston rods, connecting rods, valve gear, engine columns, air pump buckets, links and cross-heads, feed and bilge pumps, circulating pump, crankshaft and brasses were all removed from the vessel to the shops. The removal of the cylinders necessitated the lifting and repairing of the engine-room skylight.

Upon examining the various details it was found that the boxes of the cylinders, having been cut owing to their having become out of line, due to the strain caused by the rolling of the vessel before the forward engine was secured by shores at the time the columns were cut away, it was necessary to remove them. Two new pistons, complete with brass bolts, had to be supplied and fitted, the forward one having been destroyed at the time of the accident, and the after one being too small for the rebored cylinders. A new forward piston rod and cross-head was necessary to replace the broken one at time of accident. A new slide rod complete had to be fitted to the forward engine, the old one being found to be cracked at the neck. The connecting rod of forward engine had to be straightened in the fire and fitted with a complete set of new brasses. The connecting rod of the after engine also required new brasses, the old ones having been worn all away owing to the distortion of the centers of the engines. Two new columns with guide plates and air pump lever bracket were supplied and fitted complete to replace the ones cut away at the time of the accident. The air and circulating pump levers, links and gudgeons required overhaul. A new air pump, head valve and guard were fitted, the old ones having been broken at the time of accident. A new set of India rubber valves had to be fitted to replace those destroyed. A new trunk had also to be fitted to the circulating pump cover and also new valves. The starting, reversing valve and throttle valve gear had to be overhauled and adjusted. The main steam pipe required repairing and testing, as did also the steam connections to the donkey in connection with it. The crankshaft had to be lifted and adjusted. The same was also done to all the propeller shafting.

The propeller needed rekeying. The water service for crank pins and crankshaft bearings had to be replaced. A set of new lubricators had to be supplied, the old having been destroyed. The pressure gages were retested. The main condenser was overhauled and 51 tubes were found to have started, and these were made good. New indicator cocks and pipes had to be refitted to replace old ones damaged. A new gland and neck bush had to be fitted to the after cylinder, the original one being much cut owing to the accident.

The necessary work was completed in six weeks (the temporary repairs having occupied only twenty days), from which the serious nature of the accident will be seen, when so long a time was occupied in remedying defects at a modern engineering shop with every appliance for the speedy execution of repairs. F. J. S. N.

Review of Important Marine Articles in the Engineering Press

Motor Passenger Launch Violeta.—A handy little vessel built by Thornycrofts for the Algeciras Railway Co. for service between Gibraltar and Algeciras. A present the company operates a fleet of paddle steamers on the route and the new boat's performance will be an interesting comparison. The especial service for which the *Violeta* was built is the carrying of British Government mails and passengers between mail trains, to and from liners calling at Gibraltar, and acting as general handy boat to the steamers of the fleet. The vessel is 66 feet over all, 60 feet on the water line, 12 feet beam and 5 feet draft. She has a displacement of 35 tons, a passenger accommodation of 60 and a speed of 11 knots. The machinery consists of two sets of six-cylinder, four-cycle gasoline-kerosene (petrol-paraffin) engines of Messrs. Thornycroft's well-known C type, developing 70 to 80 horsepower and driving twin screws through epicyclic transmission gear at 500 revolutions per minute. A special feature is the lubrication. 700 words, with photographs and complete drawings of general arrangement.—*Engineering,* May 31.

The New German Battleships Heligoland and Kaiser.—Two distinct types of battleship design are illustrated in the last designs for the German navy. The earlier of these is for the *Heligoland* class, launched in 1909-10, and the latter the *Kaiser* class, launched in 1911-12. The dimensions of the former are: Length 546 feet, beam 93½ feet, draft 27 feet. The main armament is composed of twelve 12.2-inch guns, four of which are in turrets on the center line of the ship; the rest are in four turrets at the corners of the superstructure. A secondary battery of fourteen 5.9-inch guns is carried on the main deck. There are six torpedo tubes. The armor protection is said to be particularly effective and complete. Practically the entire hull side is armored, the maximum thickness being 10¾ inches. Turrets and bases have 11-inch protection. The normal fuel capacity is 1,900 tons, with a maximum capacity of 3,000 tons of coal and 200 tons of oil fuel. With a designed indicated horsepower of 28,000, a speed of 20.5 knots was expected, but this has been exceeded by a knot. The *Kaiser* class is 564 feet long, 95 feet beam and 27 feet draft, and of 24,500 tons displacement. The designed horsepower of 25,000 is expected to give 21 knots speed. The arrangement of guns is after the design of the British battleship *Neptune.* There are ten 12.2-inch guns and fourteen 6.7-inch guns, with ten torpedo tubes. The armor is very similar to that of the *Heligoland.* A comparison of the nine latest battleships building for seven of the powers is appended. Illustrated. 2,000 words.—*Marine Engineer and Naval Architect,* July.

The Battle Cruiser.—By Burnell Poole. An exposition of this recently evolved type of warship for the general scientific reader. Describes the necessary qualifications and sketches the history of their development, followed by tables of principal dimensions of the battle cruisers of the world's powers. Illustrated with photographs of good examples of battle cruisers. 1,400 words.—*The Engineering Magazine,* July.

The Strength of Ships—Part I.—The first of two articles giving notes from a recent German work under the above title. In beginning, attention is called to the circumstance that one of the salient characteristics of a ship, that of being largely made up of thin sheets of plating, is not met with in other structures in anything like the same degree. For this reason, and because the stresses due to wave action cannot be treated by ordinary methods, a new branch of science has to be created. The point made in this number by the reviewer, and illustrated with examples of mechanical action of material under stress, is that material in a ship's structure is much more often over-stressed than is supposed. This being beyond the yield point and being accompanied by permanent elongation of the material, it must not go so far as to lead to fracture, and the elongation must not be of such a nature to be detrimental to the general structure. That such a state of affairs exists is claimed and shown to be possible by considering the manner of making the joints in such a way that a very little yield relieves the stresses acting throughout the structure. 3,000 words.—*The Engineer,* June 28.

The Strength of Ships—Part II.—The scope of the remainder of the book is given, and briefly stated this is: Stresses on plates supported at the sides and loaded throughout its area, rivets and riveting, longitudinal stress and longitudinal framing, water pressure on sides and bottom plating, transverse strength and the effect of frames and bulkheads thereon, docking, and stresses in special parts—as thrust blocks, engine seatings, etc. Nothing can be given here satisfactorily of the treatment accorded any of these subjects. Its value may be judged from its sources, the vast data of the German navy backed up by large numbers of tests upon many parts of structures to determine what actually happened under service conditions. 3,700 words.—*The Engineer,* July 5.

Harland & Wolff's Works at Belfast.—Besides being one of the world's greatest shipyards in point of tonnage built, the Harland & Wolff Works at Belfast is especially noteworthy in the superior location and equipment of its plant. Rarely does an organization have the advantages offered by such equipment in the building of its enormous output. Its story is told from the modest beginning in 1791 to the present time, when, under the direction of Lord Pirrie, a larger ship than the *Olympic* is being built. The yard as it exists to-day is the subject of full and complete description, with some remarks on the policy of the company's management. Every department is taken separately and fully treated. Accompanying are several photographs and plates. 27,000 words. In two parts.—*Engineering,* July 6 and 12.

The Holzapfel Patent Exhaust Boiler and Silencer.—A device making use of exhaust gases from internal combustion engines to generate steam for auxiliaries, particularly the steering engine. It consists of two cylindrical, tubular boilers placed side by side, so piped up that the hot gases may be passed through each at will. The gases pass through the tubes, water surrounding them. Sea water is used, and in order to reduce incrustation a continual drip of brine is allowed to leave the boilers. Compressed air is used while leaving port before the heat of exhaust is sufficient to put the steam steering gear into commission. The apparatus is being put on the market by the Holzapfel Marine Gas Power Syndicate, Ltd., of London. Illustrated by a drawing. 400 words.—*Marine Engineer and Naval Architect,* July.

On the Best Distribution of Load Among a Number of Similar Steam-Turbine Stages Working in Series.—By E. Buckingham. A mathematical deduction of the commonly accepted solution of the problem of load distribution in compound steam turbines. While generally believed to be true, the hypothesis has generally been accepted, although not rigidly approven. The conclusion reached for both two and multiple stage turbines is that the isentropic drop should be a little greater in the first stage than in any other, slowly and uniformly decreasing from this to the lowest pressure. 300 words.—*Journal of the American Society of Naval Engineers,* May.

The Gary-Cummings Torsionmeter.—By Com. U. T. Holmes. An accurate mechanical torsionmeter as used in the United States navy is here described and shown in drawings. Briefly stated, it consists of a tube rigidly fastened at one end inside a section of hollow shafting, the other end turning in roller bearings which are made fast to the shaft. As the shaft twists under a load, the tube turns in the bearing. The amount of turning is magnified and the result recorded by metal points touching a slip of paper held tangent to the edge of the recording instrument. The degree of twist of shaft is directly proportional to the distance between the points of contact on the paper. In the instrument described, ½ degree of angular displacement of shaft was marked by 1.9 inches between the recording points. The advantages of this instrument are that it is unaffected by speed of revolution, and therefore uses the same constant for all speeds and powers; it is inside of the shaft, out of the way; weighs little and needs no adjustment after once being calibrated. A set of formulæ is worked out for use with the instrument. 2,500 words.—*Journal of the American Society of Naval Engineers,* May.

Kermode's Liquid Fuel Systems.—The use of oil for fuel is being pushed for consumption under factory boilers, rivet-heating furnaces, fire engines, melting metals and tea drying, as well as under naval boilers. The firm of Kermode's, Ltd., of Liverpool, has been developing liquid fuel systems applicable for all these uses and more, and hardly three months pass without notice of some further advance being made in the model of the burner or the method of administering oil fuel. One of their latest designs for marine work permits either fuel oil, coal or both to be used without changing the furnaces. For oil fuel three systems are in use: (1) the steam-jet system, which will recover in actual work 75 percent of the calorific value of the fuel used and the burner will work efficiently on 3 to 3½ percent of the steam raised; (2) the air-jet system, which will recover 84 percent and uses but 2 percent of the steam raised; (3) the pressure-jet system, which recovers 80 percent of the fuel in work and uses about ¾ percent or under in driving the pump. In the two last-named cases the water to drive the system may be recovered. As to comparative evaporation, whereas ordinary coal evaporates 8.5 pounds of water from and at 212 degrees in marine boilers, ordinary fuel oil of commerce, of calorimeter 19,320 British thermal units per pound, will evaporate 16.5 to 16.8 pounds of water from and at 212 degrees with the air-jet system, 16 pounds with the pressure-jet system and about 15 pounds with the steam-jet system. Photographs of the different types of installation are shown. 4,200 words.—*The Steamship,* July.

The Selandia's Maiden Voyage.—Much of uncertainty regarding the use of Diesel engines for deep-sea service in medium and large ships can only be cleared away by actual trial, and so the reports from the *Selandia's* first voyage have been awaited with interest. On a trip of 21,840 miles this ship carried 9,300 tons of freight on a consumption of 9 tons of fuel per 24 hours, with a total engine-room crew of ten men and three boys. Although some rough weather was encountered and stops were made at sixteen ports, no trouble was reported in running or maneuvering the engine. The piston rings were examined twice and found to be perfectly clean. The exhaust valves needed practically no attention the entire trip. Only in the auxiliaries, such as lubricating oil pumps and water circulating system, were any changes suggested by the experience, and these were modifications in size rather than in method of operation. The voyage seems to have disclosed no inherent defects in the four-cycle motor, as had been feared by some. 900 words.—*The Engineer,* July 19.

Screw Propellers. Determination of Diameter, Pitch and Projected Area by Means of the Effective Thrust.—By Capt. C. W. Dyson, U. S. N. All previous work on propellers by Capt. Dyson was made on the assumption that the apparent slips and propulsive coefficients of propellers working in the wakes of similar vessels, at equal indicated thrusts per square inch of projected area, varied directly as the projected area ratio. His method was to lay down the slips and propulsive coefficients for a propeller of .32 projected area ratio and one of .54 projected area ratio, and assume that the slips and propulsive coefficients for propellers of other projected area ratios would, for any value of indicated thrust per square inch of projected area, lie on a straight line joining the two. This assumption he does not now consider satisfactory, and in this treatment of the propeller problem his methods are revised and improved to allow for correction at this point and others tending to increased flexibility in use. The article considers the whole problem of propeller design and gives eight plates of charts, with descriptions and derivations. Illustrated with drawings of several types of blade outlines and sections. 17,800 words.—*Journal of the American Society of Naval Engineers,* May.

Relative Possibilities of the Diesel Oil Engine, Geared Turbine and Suction Gas Engine, as Compared with the Reciprocating Engine for Marine Propulsion.—By E. L. Orde, the Hon. Chas. A. Parsons, K. C. B., F. R S.; R. J. Walker and A. C. Holzafel. Specifications of machinery for each of these several types have been carefully prepared for the same vessel in comparison with the usual steam plant for such a ship, consisting of three single-end Scotch boilers and a three-crank triple engine. The requirements submitted to all for their comparative estimates were as follows: Length over all 412 feet, length between perpendiculars 400 feet, extreme beam 52 feet, molded depth 29 feet, draft 26 feet 1 inch, deadweight 8,465 tons, displacement 11,560 tons, speed 10½ knots and indicated horsepower 2,600. Mr. E. L. Orde gave the comparison between a Diesel oil installation and steam for this ship. His figures are in three tables of expenses for the two types and a plot showing fuel costs for each ship at varying price per ton. Whatever variations actual practice might make from his assumptions would not affect the results, as the same figures were used for both. The Hon. Sir Chas, A. Parsons gave the comparison of a steam engine with geared turbines, submitting data from the results of trials and actual service from the *Vespasian.* On trial the geared turbines showed a steam economy of 15 percent, and after two years of constant service the mechanical features of the design are entirely satisfactory. Mr. A. C. Holzafel makes the comparison for the suction gas motor. One point taken up extensively was the manner of caring for auxiliaries. These are to be operated by electricity. The main engines operate twin screws. Interesting data from his experimental vessel, *Holzafel I.,* were presented, with plates showing relative spaces occupied by machinery of each type. 13,200 words.—*Transactions N. E. Coast Institution of Engineers and Shipbuilders,* April.

Panama Canal Tolls.—By Rear-Admiral Chas. H. Stockton, U. S. N. A brief review of this timely subject from the standpoint of international law. The provisions of the Clayton-Bulwer and Hay-Pauncefote treaties are stated and the policy generally agreed upon in such cases among the nations. The interpretation placed upon the discrimination clause admits the justice of granting free tolls to vessels trading from one coast to the other, but questions the propriety of doing so on the grounds of the total removal of such ships in time of war, with the consequent damage to the trade. This traffic, it is claimed, should be open to vessels of all nations. Only in this way can the monopoly of traffic by railroad-owned or operated ships be averted. The policy of free ships for this trade is also urged. 1,800 words.—*United States Naval Institute Proceedings,* June.

Propulsive Machinery and Oil Fuel in the United States Naval Service.—Capt. C. W. Dyson, U. S. N. A study of recent improvements in naval machinery design, particularly with regard to the use of turbines or reciprocating engines, and the introduction of oil for fuel. The latest reciprocating engines have increased the number of expansions, adopted straight ports and the resulting smaller clearances, forced lubrication system, the use of superheated steam and increased vacuum. The practical results have been an increased steam economy, as shown by a comparison of the engines of the *Delaware* and those of as recent a ship as the *Birmingham,* where the difference was 22.66 percent at full power in favor of the former. As to the weight of the machinery installation, the reciprocating engine is favored, as in the instance of the *Delaware,* with 773 tons, and *North Dakota,* whose turbine installation weighs 783 tons. The losses in turbines at cruising speed are well known, except in the cases where cruising turbines are used. The boiler plant required has been found to be more for the turbine battleship referred to. The comparison is fully carried out in detail and shows the reasons for installing reciprocating engines in the two latest battleships. Some valuable and very interesting figures are given, which will not be overlooked by designers. In speaking of the adoption and use of oil fuel in the navy, Capt. Dyson describes briefly the system in use and gives tables of results from evaporative tests on several torpedo-boat destroyers. By adopting oil as fuel on the battleships *Nevada* and *Oklahoma,* the fire room weights have been decreased over 25 percent, the fire room force halved, while the length of ship required for boilers has been decreased from 128 feet to 66 feet. 9,600 words.—*Journal of the American Society of Naval Engineers,* May.

An Improvement in Floating Dry Docks.—By Civil Engineer A. C. Cunningham, U. S. N. The ordinary form of floating dry dock has the disadvantages of poor efficiency in self-docking, necessity of self-docking for complete painting and limitation as to size of ships possible to be carried. The design shown here is a combination of the principles of the Rennie pontoon dock and the Cunningham sectional dock, in which the sections are integrally connected together above the waterline. Outline sketches show how one section may be docked at a time with minimum of maneuvering and lifting power. By providing one extra section, the cleaning can go on continually, each taking its turn as spare and insuring good state of preservation of the whole structure. The design has the advantage of possible longitudinal expansion to suit the vessel lifted by adding more pontoons to the ends. When it is desired to increase lifting capacity without increasing length, deeper or wider pontoons may be used. With units of any size there is always the possibility of rising each pontoon separately in lifting smaller vessels. 1,500 words.—*United States Naval Institute Proceedings,* June.

The Enlargement of the Kaiser Wilhelm Canal.—A modern engineering work of more than usual size and of large commercial importance is the enlargement of the Kaiser Wilhelm Canal now nearing completion. Opened for the first time in 1895, the demands of traffic urged its enlargement a little more than ten years later. The improvements being carried on are on a large scale, a few general dimensions being, bottom width 144 feet instead of 72 as formerly, water level width of 335 feet instead of 216, depth 36 feet and a canal profile of 825 square meters (8,880 square feet) instead of 413 square meters. Curves will be straightened out, the least radius being 1,800 meters and most of them 3,000 meters. The locks at the entrances are being replaced by the biggest locks in existence, surpassing even those on the Panama Canal. These will have a useful length of 1,083 feet, width 147.6 feet, depth 45.25 feet. Each lock will be fitted with three sliding gates, each weighing 1,000 tons. The labor problem is an interesting feature. Seven thousand six hundred laborers were employed last summer, as many as possible being Germans. Barracks are provided as quarters for all single men, and everything possible is done to suppress indulgence in alcoholic drinks without absolutely prohibiting them. Sunday and overtime work is allowed only in exceptional cases. Every laborer is medically examined and remains under medical control. The whole work, including dredging, building locks and rebuilding railroad bridges over the canal, is being carried on without interuption to traffic. A sum of approximately fifty-five million dollars (£11,300,000) was granted in 1907 and the work is to be completed by 1915. 5,600 words.—*Engineering,* June 21.

Messrs. Workman, Clark & Co.'s Works at Belfast.—Preparatory to the coming visit of the Institute of Mechanical Engineers to Belfast, the plant of Workman, Clark & Co. is the subject of a lengthy detailed description in a recent number of *Engineering.* Not only are the mechanical features of the place described, but the history of the yard's development is sketched. Begun in 1880, with four acres of ground on the north side of River Lagan to the east of Belfast Harbor, it has steadily progressed in size and equipment until at the present time it has in its 82½ acres of land two complete shipbuilding yards and an engineering works, which are capable of turning out ships up to 1,000 feet in length and machinery of the latest designs to correspond. The North Yard, so called from its location with respect to the River Lagan, has seven shipbuilding berths, two of which, added in 1910, are easily capable of taking ships of the largest dimensions now building. In the South Yards are berths for five ships up to 523 feet long. The two yards have separate organizations and a friendly rivalry exists between the two, which is productive of a desirable efficiency in production. The engineering works of the company are opposite the South Yard in Queens Road. Besides a large and complete boiler shop and machine shops, this contains the power plant for itself and the South Yard, smith shop, separate drawing and time offices, stores and dining room for the men. The descriptions of all are complete, giving in detail the account of any machine of unusual size or purpose, the method of drive, features of power supply, material handling, etc. The company's increasing prosperity, in spite of the fact that the materials of shipbuilding are not native to Ireland and the scarcity of skilled labor, is evidence of enterprise, continuous attention and ability in conducting the works in an efficient and economical manner. The article is well illustrated with photographs and drawings showing the locations and plans of the works. 12,500 words.—*Engineering,* July 19.

Inspection Duty at Navy Yards.—By Lieut.-Commander T. D. Parker, U. S N., Honorable Mention, U. S. Naval Institute Prize Essay Contest, 1912. An essay on the subject of organized inspection departments for navy yards and shipbuilding plants doing naval work. The general question of what inspection is and what it should be, its difficulties and how they may be best met with present facilities, is first taken up. Specific suggestions are then made for the building up of a small organization for the broad field of all necessary inspection of this kind of work, and details worked out complete, including the duties of each member of the staff. Practical examples are given and the field of naval inspection is made clearer, the aims more definite and the methods easy of adoption. Written by a naval officer, for an audience in the naval service, it is, of course, for this need primarily, but the suggestions offered are by no means applicable in the navy alone, and the resourceful manager may easily find useful points to pick up. 10,800 words.—*United States Naval Institute Proceedings,* June.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

The favorable condition of shipbuilding in the United States during the fiscal year is shown by the returns filed with the Bureau of Navigation, where it was reported that on July 1, 1912, one hundred and twenty steel vessels, aggregating 254,000 gross tons, were under construction, or under contract to be built, as against less than 100,000 gross tons at the same time a year ago. This means an increase of tonnage for the year of over 154 percent, and while the volume of tonnage reported is not large when compared with the tonnage under construction in Great Britain, where all previous records are being surpassed, yet when compared with the capacity of the American shipyards it is evident that the American shipbuilders will be more busily employed for several years to come than in the past decade. The situation in the American shipyards on the Atlantic coast is more clearly emphasized by the fact that, when in September sixteen yards were invited to bid on a steel hull designed by a prominent naval architect for early delivery, only five of the sixteen were interested enough to ask to see the specifications, the remaining eleven reporting that they are too busy with work in hand to consider taking on anything more at present for early delivery. The tonnage building on the Great Lakes shows a decrease of about 10,000 tons, as compared with a year ago, and part of the current year's construction is designed for salt water use. In this increase of shipbuilding the influence of the coming opening of the Panama Canal is manifest, as upwards of 80,000 tons are building for use through the canal. Preparations for the use of oil for fuel instead of coal are also evident in the shipbuilding returns, for seventeen tank steamers, ranging from 2,200 tons to 6,500 tons, are now under construction.

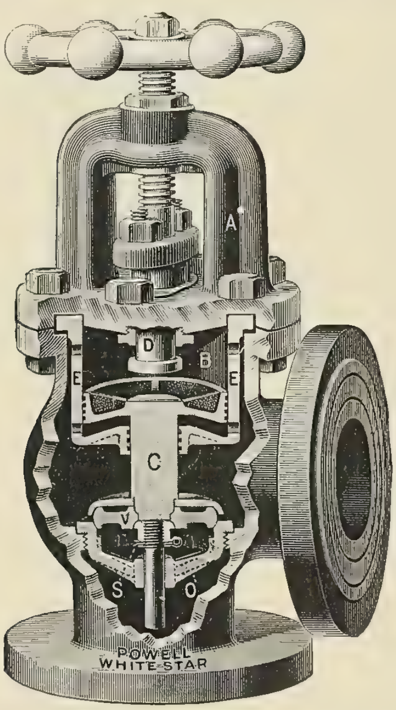
Elsewhere in this issue will be found those sections of the Panama Canal Act which relate directly to marine affairs. A careful perusal of these sections shows that in almost every case the limitations of the Act are clearly defined, except that in Section 5 one of the provisions, which in all probability will have a most important effect upon the shipbuilding industry, is placed in the hands of the Secretary of the Treasury for its final interpretation. This provision specifies that all materials of foreign production which may be necessary for the construction or repair of vessels built in the United States, and all such materials necessary for the building or repair of their machinery, and all articles necessary for their outfit and equipment, may be imported into the United States free of duty under such regulations as the Secretary of the Treasury may prescribe. At present the customs division of the Treasury Department is engaged in formulating these regulations, and it is not probable that they will be issued before the middle or the latter part of October. Until that time all importations coming under this head will be admitted under an arangement whereby the question of the duty to be paid, if any, will be held in abeyance until the regulations are issued. It is evident that a literal interpretation of this provision will result in one of the most sweeping free trade enactments that the United States has ever experienced, since everything that goes into an American ship, including material, machinery and equipment, can be imported free of duty. The important question to be settled, then, and the one that will have an immediate effect upon both American and foreign manufacturers, is whether the Act means that all materials, supplies and equipment for shipbuilding shall be admitted free of duty; or, if not, where shall the line be drawn? We understand that the Treasury Department is seeking all the information that can be secured from interested sources before completing these regulations, so that anyone whose interests will be affected in any way by this law should make known at once to the Treasury Department his views on this question.

Improved Engineering Specialties for the Marine Field

The Powell "White Star" Automatic Non-Return Boiler Valve

In steam plants where more than one boiler is in use the value of a non-return boiler valve cannot be reckoned too highly if it eliminates, as it is claimed to do, the possibility of steam escaping into a boiler which might be unexpectedly out of commission or closed off for repairs. A feature in the operation of such a valve is the prevention of danger to workmen when engaged inside a boiler for cleaning or the insertion of new tubes.

In the Powell "White Star" automatic non-return boiler valve illustrated herewith it is claimed the latest boiler laws have been carefully met; the outside screw stem and yoke top



being one of the particular specifications; all parts throughout are of extra heavy pattern and good for working steam pressures up to 250 pounds. They are made either screwed or flanged ends.

The body and yoke are cast of a close-grained iron of high tensile strength. They are connected together by steel bolts and nuts of sufficient number to firmly bind the flanged faces together. The sheet packing is housed in a recess in the body neck flange under the projecting top of the dash-pot, and is held firmly in place by the compression given by the bolts and nuts when assembled.

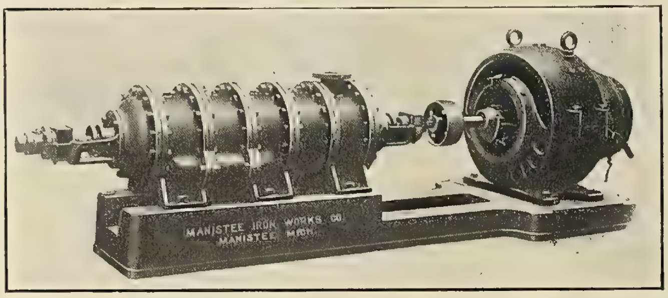
The disk plunger C (to which is attached the disk holder R) works in the dash-pot E, and they are cast of steam bronze composition. The opening in the dash-pot E, through which the stem of plunger C is guided, also the rim of the upper part of the disk plunger, are grooved, so that these parts may work with a minimum of friction, and respond readily to any variation in the pressure. The dash-pot has four vent holes at top and bottom to allow the draining of any condensed water that may collect therein. The lift of the disk is equal to the depth of the dash-pot, insuring a full opening. The height of the lift is regulated as desired by raising or lowering the screw stem D.

The disk and seat are made of white "Powelium" bronze. The disk is regrindable, reversible and renewable, and is secured in the disk holder by nut S, which is locked in place by a cotter pin, and cannot possibly unscrew and drop off. The seat is renewable, and is cast with a guide for the lower part of the disk plunger stem, holding same perpendicular to the seat at all times. The expansion of the seat and body is uniform, the composition of the seat being made with that in view. Whenever necessary to do so the seat can be readily renewed by inserting a flat tool between the lugs projecting from the inner circle and unscrewing same.

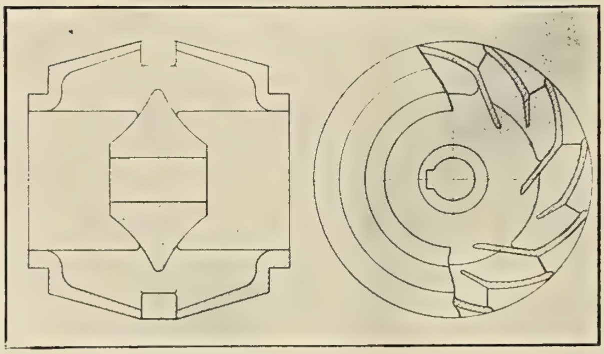
These valves are made by The William Powell Company, of Cincinnati, Ohio.

Rees Roturbo Pump

The Manistee Iron Works Company, Manistee, Mich., which is the American licensee of the Rees Roturbo Development Syndicate, Ltd., of Wolverhampton, is manufacturing the Rees Roturbo patent pressure chamber centrifugal pump. The characteristic feature of this type of pump is that it is a true turbine pump, the rotor having a strong turbine effect. This turbine effect is secured by making the impeller of large capacity for storing water, which is maintained by rotation



REES ROTURBO FEED PUMP



SECTION OF IMPELLER

at a constant maximum internal pressure independent of the external head, and by an ingenious application of the Venturi law transforming and extracting this pressure with a minimum amount of loss. Consequently, instead of throwing away the surplus speed energy of the water discharged when the head of delivery is reduced, the energy is extracted from the water before it leaves the pump casing. It is claimed that in this way all cavitation troubles are done away with, due to the internal pressure, and as there are no delicate vanes in the impeller there is no risk of breakage at this point. In a pump constructed in this way it is claimed that the power absorbed when running at a constant speed remains practically constant for all heads of discharge, and never appreciably ex-

ceeds that required for the head for which the pump is designed. Thus it is claimed that the pump is practically self-regulating in the highest degree, as it is impossible for any variation of head to throw an excessive strain on the driving motor. Whereas an ordinary centrifugal pump is limited to the designed capacity or head for operation at the best efficiency, since if the head or the volume of water vary it is necessary to change the speed of the pump or energy is lost, on the other hand, the Roturbo pump is designed so that it will automatically and hydraulically regulate the power absorbed under varying conditions.

The illustrations show the latest type of the Rees Roturbo boiler feed pump, direct coupled to an enclosed, ventilated, direct-current motor. The pump impeller consists of a series of pressure chambers, which are mounted upon a central shaft supported upon bearings throughout the whole length except that portion passing through the chambers. The whole pump is claimed to be in perfect hydraulic balance. The feed pump on test delivered 18,000 gallons per hour against a boiler pressure of 220 pounds per square inch, and required 50 horsepower for operation, showing a pump efficiency of 76.5 percent.

Sprague Electric Grab-Bucket Cranes

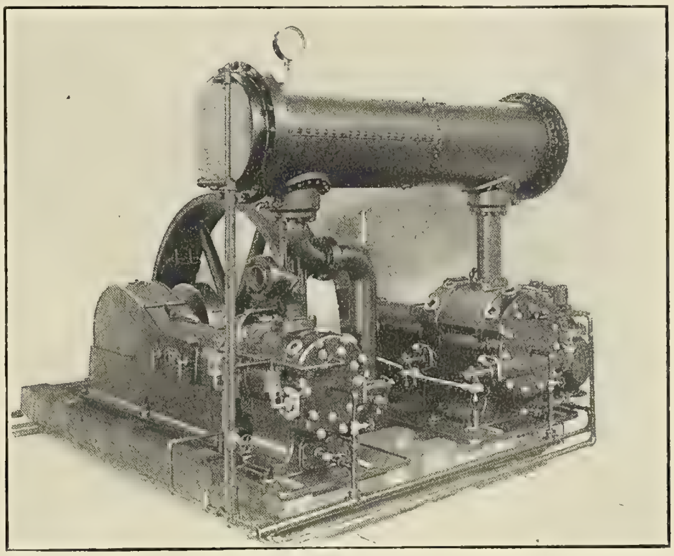
The problem of unloading bulk cargo freighters usually requires an apparatus that will not only remove the cargo from the hold of a vessel but also deposit it at a convenient place either on the pier or on shore. To meet these requirements the Sprague Electric Works, New York, has placed on the market a grab-bucket power crane which, it is claimed,

can shovel, lift, convey, deposit and pile bulk material without aid from any outside source. The apparatus consists of a clam-shell bucket which is operative by electrical means, and which conveys the loaded bucket along an I-beam runway, which can be supported on an independent structure or some existing structure as the case may be. A frame built of structural steel and steel castings contains the hoisting drum, motor, gears, etc., and is suspended from two trucks which support and carry the entire mechanism. The bucket is operated by three ropes which are anchored to two drums. A special system of controlling the apparatus is provided by which the operator, whose position is on the crane itself, can, with a single controller, perform all the operations necessary in proper sequence for lifting, conveying and depositing bulk cargo.

A New Air Compressor

The Chicago Pneumatic Tool Company, Chicago, has placed on the market a new enclosed, self-oiling, belt-driven air compressor, known as Class M-CB, which has two-stage air cylinders, 16 inches and 10 inches in diameter and 12 inches stroke. At its rated speed of 210 revolutions per minute it has a displacement of 576 cubic feet per minute.

Mechanical inlet air valves of the semi-rotary Corliss type are used, actuated by eccentrics on the compressor shaft. The



discharge valves are of the company's air-cushioned poppet type, placed radially in the heads. This combination, it is claimed, insures high volumetric efficiency and the elimination of valve troubles, as the valves are interchangeable and accessible for adjustment and renewal.

The heads and cylinder walls are completely water-jacketed and arranged with independent water supply, permitting the use of solid gaskets between heads and cylinders. The frames are full tangye type with bored crosshead guides completely enclosing the crosshead bearings. The cranks and eccentrics are enclosed with substantial planished iron casing, enabling complete flood lubrication of the main bearings, crosshead and moving parts by means of automatic gravity lubrication. Inlet valves and pistons are lubricated by large glass sight-feed lubricators on the caps of inlet valves, and all valve gear bearings have extra large compression grease cups.

The inter-cooler is of the steel shell marine condenser type, mounted overhead, provided with composition tubes, baffle plates and separator drip pockets. The air cylinders are bolted directly to the tangye frames, and in addition extend down to large sole plates with drip guards all around.

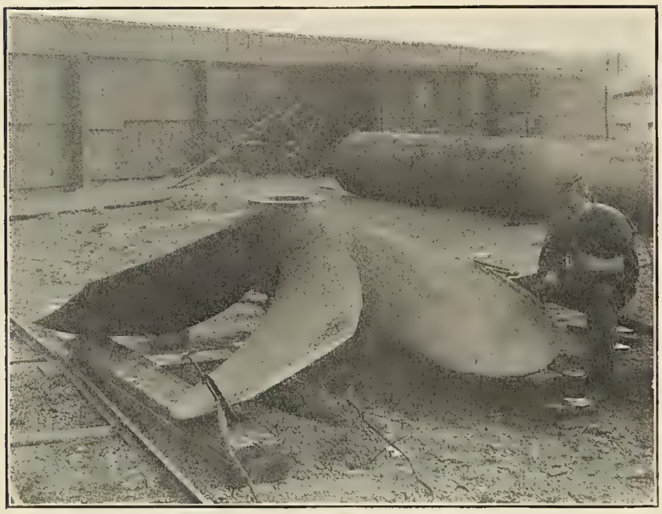
The cranks are of the balanced disk type pressed and keyed to shaft. The driving pulley is split-keyed to shaft and machine-true on face and edges. It is of unusually heavy design to give the necessary fly-wheel effect.

Control is effected by an improved throttling in-take controller operated by receiver pressure, capable of close regulation and adjusting the load to meet the air demands, so that the power consumption is reduced to a minimum.

The same type of machine is furnished in capacities up to 4,000 cubic feet per minute. Equivalent sizes and capacities can be furnished in short belt drive and motor drive with motor mounted directly on compressor shaft.

Electric Arc Welding in Ship Repairs

A successful electric arc welding plant consists essentially of a generator designed to maintain constant electromotive force under a fluctuating load; a special rheostat, either manually or automatically controlled, depending upon the operating conditions; a welding clamp of copper or iron and an assortment of welding pencils. These pencils are secret alloys, the composition and dimensions being chosen for each class of work. With these pencils are supplied special refractory fluxes which are applied by the user in accordance with directions, and these fluxes form the most essential part of the welding process, as upon them depend the quality of work and the speed of operation. An apparatus of this sort, which has



been used successfully in marine repair work, has been placed on the market by the Electric Welding Company, Produce Exchange Annex, New York. An example of the utility of this welding apparatus is shown in the illustration, where the broken tips of the propeller blades are being restored. Propellers have offered one of the most difficult problems to the arc welder, because, in the first place, it is difficult to weld cast iron, and then each grade of cast iron requires special treatment. Besides renewing broken blades by welding on new tips, holes or pitted surfaces can be filled and smoothed up to the true profile by depositing metal either with a carbon or metal pencil. In repairing tips, new tips are cast, the edge to be welded beveled off from both sides and welded. Tips weighing as much as 500 pounds have been successfully welded, and it is claimed that there is no limit to the size that can be handled. The Electric Welding Company above mentioned has welded propellers up to 20 feet in diameter. The repairing of marine boilers is also one of the most highly developed uses of arc welding. Usually cracks develop along the calking edges and extend toward the rivets and between them. Such cracks can be taken care of easily by arc welding, or, better still, if the furnace flange, wrapper sheet and the tube sheet are welded up and wasted parts filled with new metal such cracks can be prevented.

Demonstration of a Patent Submersible Pump

An interesting demonstration was recently conducted at Messrs. Gwynnes, where a flooded barge was pumped out by a small submersible motor pump, manufactured by Submersible & J-L Motors, Ltd., Southall, Middlesex. The carrying capacity of the barge was 100 tons, and when fully flooded the amount to be pumped out was considerably above this, or approximately 125 tons. The motor pump consisted of a 10-horsepower submersible electric motor combined in one casing, with a 5-inch centrifugal Gwynne pump, running at 95 revolutions per minute off a 220-volt circuit, delivering 600 gallons per minute. The pump was suitable for operating at any head up to 35 feet. The barge had been previously submerged, and when the tide fell so that the gunwales began to show above water the pump was put in operation, and after pumping for about thirty minutes the barge was practically emptied. In this electric motor the water circulated freely through the interior and the bearings, which are adapted for water lubrication.

The control of the motor pump can be operated from a distance by the switch, and the pump started and stopped above or below water as required. In marine work motor pumps situated below the waterline could be operated from the upper deck of the ship. It is recommended that an oil engine generating plant be used for supplying the electric current, which would be quite independent of the boilers, and placed on an upper deck; thereby the risk of water interfering with the operation of the electric plant would be overcome.

Technical Publications

Electrical Propulsion of Ships. By H. M. Hobart. Size, 5½ by 8½ inches. Pages, 162. Illustrations, 43. New York, 1911: Harper & Bros. Price, $2 net.

This book, which was published first in England by Harper & Bros., was reviewed on page 85 of our February, 1912, issue.

Ship Wiring and Fitting. By T. M. Johnson. Size, 4¼ by 6½ inches. Pages, 80. Illustrations, 47. New York, 1911: D. Van Nostrand Company. Price, 75 cents net.

Although this book is a small one and deals with a subject about which a good deal could be written, yet it will be found very useful to a marine engineer who has had little experience with electrical machinery. Almost every modern vessel is equipped with an electrical power plant, and electricity is used for various power purposes, for lighting the ship and sometimes for heating. Such apparatus is, of course, designed and specified by electrical engineers when the vessel is built, but after the vessel is turned over to its owners the duty of maintaining the electrical machinery falls upon the engine room staff. For this reason some knowledge of the fitting and, particularly, of the wiring is necessary. No attempt has been made in this book to describe in detail the construction of electrical machinery, but the general types of dynamos, engines, motors, switchboards, etc., are given, and then the usual methods of wiring different types of vessels are described. Lamps, bells, telephones, fans and special apparatus are taken up in the closing chapters.

Elementary Internal Combustion Engines. By J. W. Kershaw. Size, 5¼ by 7½ inches. Pages, 174. Illustrations, 117. New York and London, 1912: Longmans, Green & Company. Price, American edition, 90 cents net; English edition, 2/6 net.

The contents of this book are principally of a descriptive character, in which various types of internal-combustion engines and their fittings are described. It was intended that the book should give an elementary account of the construction and working of internal-combustion engines and gas producers, and that it should serve as an introduction to more advanced works dealing with the subject from a theoretical standpoint. The book is thoroughly up to date, because the engines described are mainly manufactured products now being placed on the market. Almost every type of internal-combustion engine is described, including gas engines, oil engines, gasoline (petrol) engines and other combustion motors. Only one chapter is devoted exclusively to marine engines, where the advantages and disadvantages of heavy oil engines for marine work are discussed.

A B C of Hydrodynamics. By R. de Villamil. Size, 5½ by 8½ inches. Pages, 135. Illustrations, 48. London, 1912: E. & F. N. Spon, Ltd. Price, 6/– net.

The title of this book would lead one to expect an elementary treatise on the subject of hydrodynamics. A perusal of the first chapter, however, which deals with the confused state of the subject of resistance of liquids, discusses the works of Lord Rayleigh, Lord Kelvin, Dr. Fleming and Dr. Hele Shaw, which will readily be recognized as advanced treatises on the subject. To fully appreciate the author's discussion it is therefore essential that the reader should be somewhat familiar with the works from which he quotes. There are thirteen chapters in the book, which cover in general the subjects of the movement of liquids and the law of flow, the resistance of liquids, viscosity and fluid friction and the motion of water in the rear of a body exposed to a stream. Quotations and references are made freely from the works of such authorities as Newton, Lancaster, Lamb, Dubat, R. E. Froude, Langley, Helmholtz, Prof. Perry, Prof. Osborne Reynolds, Col. Beaufoy Stokes, J. Bourne and others. Each chapter is closed with a few paragraphs summarizing the contents of the chapter.

Applied Methods of Scientific Management. By Frederick A. Parkhurst, M. E. Size, 6 by 9 inches. Pages, 320. Illustrations, 46. Plates, 9. New York, 1912: John Wiley & Sons. Price, $2 net. London: Chapman & Hall, Ltd. Price, 8/6 net.

Scientific management is a subject on which writers are apt to theorize and generalize regardless of the results obtained in practice. This tendency, however, has been avoided in this book, and the subject has been treated from the practical point of view as the result of the author's extensive experience along these lines. In the preface he states his belief in adapting all tools to meet each existing condition as found. He believes in developing an existing plant to its highest possible efficiency before making large outlays for extensive alterations or additions, and this same principle he applies to the placing, development and advancement of each individual member in the work's organization. The obligations of the employer and employee to each other are not overlooked. Their interests are mutual, and the principles involved tend toward the promotion of their combined progress and prosperity. He states that the human element is at once the most important factor and the greatest variable in the problem which the organizer has to solve, and this his success depends largely upon his ability to recognize and handle this phase of the proposition.

Through Holland on the "Vivette." By E. Keble Chatterton. Pages, 246. Illustrations, 60. London, W. C., 1912: Seeley Service & Company, Ltd. Price, 6/– net.

Mr. E. Keble Chatterton has again placed us under a debt for a very readable book on a cruise which he made in his yacht *Vivette* from Harwich to Dover, thence to Calais, along the Belgium coast to Flushing, Amsterdam, and back. The *Vivette* is a 4-ton cutter, 25 feet over all, and is best described as a small edition of the Bristol Channel pilot cutters, which are reckoned to be the finest seaboats of their size and rig to be found anywhere. To those of our readers who are familiar with the writings of Mr. Chatterton, we need only say that the present volume is on a par with his other works. He is a keen observer, and not the least entertaining sections are descriptive of the places and people seen when he has put ashore to replenish stores. To the yachtsman, of course, the book specially appeals, as it is written by a yachtsman of experience and a writer of ability. But the non-sailing man will find it almost as equally enteresting for the entertaining descriptions of Dutch life with which it abounds. Mr. Chatterton had a keen artist for a companion, and the reproduction of Norman Carr's photographs and sketches add considerably to the value and interest of the book. The last half-dozen pages are devoted to sailing directions for anyone who is anxious to carry out a sailing tour through Holland.

Hendricks' Commercial Register of the United States for Buyers and Sellers. Twenty-first edition. Size, 7½ by 10 inches. Pages, 1,574. New York, 1912: S. E. Hendricks Company. Price, $10.

The twenty-first annual revised edition of "Hendricks' Commercial Register of the United States for Buyers and Sellers" has just been issued. Established in 1891, it has been published annually since that time. Its aim is to furnish complete classified lists of manufacturers for the benefit of those who want to buy as well as for those who have something to sell. It covers very completely the architectural, engineering, electrical, mechanical, railroad, mining, manufacturing and kindred trades and professions. The present is by far the most complete edition of this work so far published. The twentieth edition required 108 pages to index its contents, while the twenty-first edition requires 122 pages, or fourteen additional pages. As there are upwards of 400 classifications on each page, the fourteen additional pages represent the manufacturers of over 5,000 articles, none of which have appeared in any previous edition. The total number of classifications in the book is over 50,000, each representing the manufacturers or dealers of some machine, tool, specialty or material required in the architectural, engineering, mechanical, electrical, railroad, mine and kindred industries. The twentieth edition numbered 1,419 pages, while the twenty-first edition numbers 1,574, or 155 additional pages. An important feature of this commercial register is the simplicity of its classifications. They are so arranged that the book can be used for either purchasing or mailing purposes. The book also gives much information following the names of thousands of firms that is of great assistance to the buyer, and saves the expense of writing to a number of firms for the particular article required. The trade names of all articles classified are included as far as they can be secured.

Obituary

Mr. John Haug, consulting engineer and naval architect, died Sept. 9 at his home in San Francisco, Cal. Mr. Haug, who had many friends in marine circles all over the world, was a native of Germany, and there acquired his first experience in engineering work. He was then associated, in England, with the late Mr. J. Macfarlane Gray, afterwards coming to the United States, where he entered into partnership with Mr. Archbold, who had been chief engineer of Commodore Perry's expedition to Japan in 1852. Mr. Haug was ship and engineer surveyor to Lloyd's at Philadelphia from 1880 to 1900, when he resigned to devote his time to consulting work. He designed ships and machinery and superintended construction for the Philadelphia & Reading Railway Company, the Red D Line, the New York & Porto Rico Steamship Company, the Chesapeake Steamship Company and the Standard Oil Company. He was a pioneer in the introduction of bulk oil vessels, and later in the application of internal-combustion engines to their propulsion, designing and building the first successful internal-combustion tankers in the United States while engineer-in-chief of the marine department of the Standard Oil Company, of California.

A total of 224 vessels, aggregating over a million tons, have been built, or are now under construction, according to the Isherwood system of longitudinal framing. Of this shipping 392,000 tons are oil-tank vessels, which represent about 76 percent of the total tonnage of oil steamers now building throughout the world. In the United States, where seventeen oil-tank vessels are now under construction, twelve of them are being built to the Isherwood system.

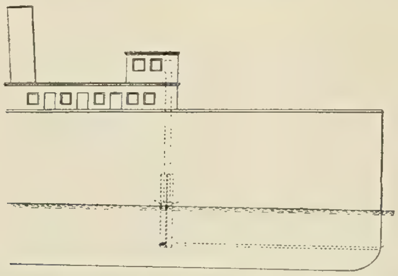
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

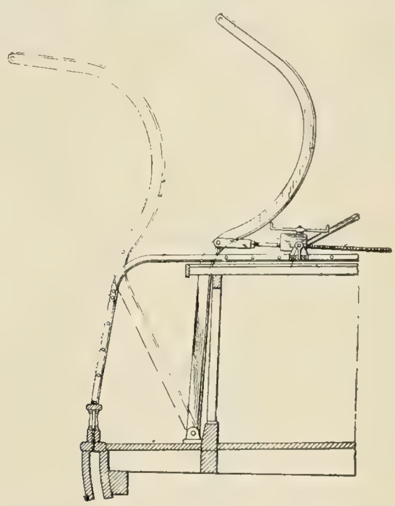
1,020,980. SHIP-SPEED INDICATOR. LEWIN J. HEATHCOTE OF BALTIMORE, MARYLAND.

Claim 2.—In a ship speed indicator the combination with a receptacle having a water inlet near its bottom and below the water line, of a float in said receptacle; a pipe extending from the said inlet to the exterior of the ship below the water line; an indicator device; means for supporting said indicator device; connections between the float and indicator device and means for adjustably securing the indicator device with respect to its support and also with respect to the float. Seven claims.



1,021,545. SHIP'S DAVIT AND MEANS FOR OPERATING THE SAME. WILLIAM L. MESSICK, OF IRVINGTON, VIRGINIA.

Claim 1.—In combination with the deck of a vessel and a davit pivoted thereto, an elevated structure composed of separated bars which extend transversely of the deck, between which bars the davit is adapted for vibration, a trunnioned block supported by the elevated bars, an interiorly threaded sleeve adapted for rotation within the block by means of gearing, and a threaded bar which extends through the interiorly threaded sleeve and is pivoted to the davit. One claim.



1,023,843. BILGE-DISCHARGING DEVICE. JOHN J. HALL, OF BUCKSPORT, ME.

Claim 1.—A bilge-discharging device consisting of a tubular outlet member adapted to be secured to a ship hull, a valve casing threaded on said member and provided with an inclined valve seat, a check valve pivoted in said casing to engage said valve seat and adapted to occupy when in a closing position an inclined relation to said valve casing and adapted to open outwardly of said valve seat, a cap threaded on said valve casing above said valve, a second valve casing threaded on the first valve casing and provided with downwardly converging valve seat guides, a valve V-shape in cross section movable between the valve seat guides and means for forcing the last valve in closing position. One claim.

1,023,477. SHIP CONSTRUCTION. JOSEPH R. OLDHAM, OF CLEVELAND, OHIO.

Claim 1.—In a ship or vessel having water ballast chambers and anti-rolling tanks along the upper wings of holds, a plurality of transverse girders, beneath the decks, constructed with a large hollow, lower flange, joining and supporting the anti-rolling tanks and water ballast chambers, and forming a strong and watertight conduit or channel adapted for the conveyance of free water between said anti-rolling tanks. Ten claims.

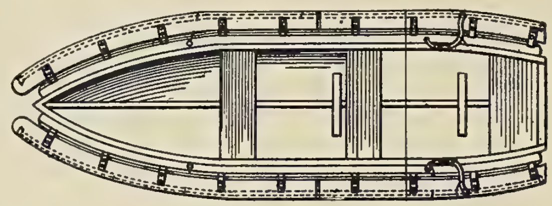
1,024,682. CONSTRUCTION OF BOATS AND SHIPS. WILLIAM HENRY FAUBER, OF NANTERRE, FRANCE.

Claim 1.—A hydroplane boat provided with a plurality of hydroplanes arranged in stepped relation and forming the flotation surface of its bottom, at least one of said hydroplanes consisting of two hydroplane members arranged at opposite sides of the center line of the bottom and inclined laterally and downwardly toward said center line; said hydroplane members having their angle of rearward inclination at said center line less than their angle of rearward inclination at their outward lateral margins. Twenty-nine claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

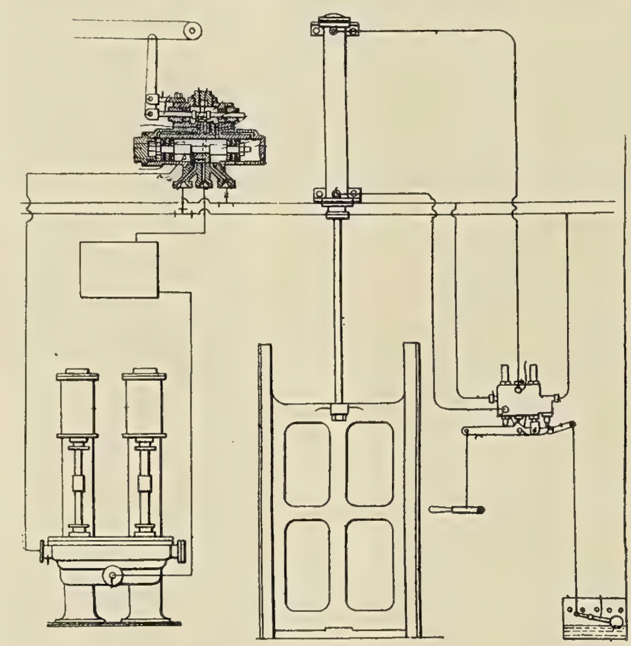
3,808. ATTACHMENTS FOR LIFE BOATS. A. E. WICKMAN, WILLMAR, MINN.

Tubular tanks extend along the sides of the boat, and each contains oil and compressed air separated by a flexible diaphragm. A pipe leads from the oil compartment to a distributing pipe, also running lengthwise of the boat, and can be opened from the boat to allow the air to force out oil for calming the sea. The oil and air container also serves as a buoyancy outrigger.



13,415. FLUID-PRESSURE APPARATUS FOR OPERATING BULKHEAD AND OTHER DOORS. F. J. PIKE, BECKENHAM, AND H. NEVILLE, FOREST HILL.

By this invention a two-way reversing valve is used at each door between the mains and the door cylinder, and is kept in its normal position, in which the doors can be opened or closed from the bridge in such a way that, when operated locally to reverse the bridge control, it returns to normal when locally released. For closing one or more doors by the rising of a float in the bilge, each door valve has a plunger normally subjected to pressure to reverse the door valve subject to the control of a trigger operated by the bilge float. To reverse the door valve the plunger may, for example, be subjected to pressure in the main under pressure when the doors are opened from the bridge or to spring pressure for the same purpose, and also to fluid pressure in the other, or closing main, in which case the fluid pressure counteracts the spring. To provide that a door when partially or quite closed may be held against simultaneous opening from the bridge a non-return valve is located, and when closed it either prevents exhaust from the closing end of the door cylinder or cuts off connection with the opening end of it. This valve is normally held open, and is closed to eliminate opening from the bridge. Where the doors are not to open simultaneously from the bridge a non-return valve is located so that when closed it either prevents exhaust from the closing end of the door cylinder or cuts off connection with the opening end of it, and which is normally held closed by the flow to or from the cylinder, means being provided for opening the valve locally to open a closed door.



29,310. FLUID PRESSURE APPARATUS FOR OPERATING BULKHEAD AND OTHER DOORS. F. J. PIKE, BECKENHAM, AND H. NEVILLE, FOREST HILL.

Relates more particularly to controlling valves for a reversible two-main system, one main being subjected to pressure and the other opened to exhaust. These mains are alternatively connected to pressure and exhaust for simultaneously opening or closing a number of doors from a central station. The door controlling valve has a slide having a flat face and so fitted that the pressure fluid is active upon only a portion of the arena of the back of it, mechanical devices pressing it against its seat. The application of such valves to the system is described.

International Marine Engineering

NOVEMBER, 1912

The United States Red River Hydraulic Dredge Waterway

Early in the summer of this year the Dubuque Boat & Boiler Works, Dubuque, Ia., delivered to the United States Engineers at Vicksburg, Miss., the steel self-propelled hydraulic dredge *Waterway*, shown in Fig. 1. The dredge is a steel hull boat fitted with the ordinary type of stern-wheel towboat machinery, and a sand hydraulic pumping plant for river dredging. The dredging outfit also includes four steel pontoons and a pipe line, together with a full complement of auxiliary gear for handling the plant. The dimensions of the dredge itself are: Length between perpendiculars, 142 feet; beam, molded, 34 feet; depth, molded at center line, 7 feet; depth, molded at sides, 6 feet 8 inches; sheer, forward, 6 inches.

FIG. 1.—THE WATERWAY EN ROUTE FROM THE BUILDERS' WORKS TO VICKSBURG

The general arrangement and construction of the hull are shown in the accompanying illustrations, the main scantlings being indicated on the midship section.

The hull is framed transversely and stiffened by four transverse and two longitudinal watertight bulkheads, and by three longitudinal lattice trusses. The transverse bulkheads are worked intercostally between the longitudinal bulkheads and between them and the sides of the boat. The longitudinal bulkheads, on the other hand, are continuous from the bow plate to the main transom. They are placed 5 feet 8 inches on either side and are parallel to the boat's center line. The three longitudinal lattice trusses are also continuous and uniform from the bow to the stern, except where modified at the cockpit and boat ends, running in general parallel to the boat's center line. Each consists of a similar top and bottom chord and of lattice panels spaced 5 feet centers composed of the members shown in the framing plans, Fig. 3.

The hull has no overhanging guards, but at the stern there are on each side of the boat cylinder beams of I-section extending 48 feet 4½ inches in length and projecting 20 feet 3 inches aft of the false transom for the propelling engines. The after end of each cylinder beam is supported by a 1¾-inch diameter chain, the chain, or samsom posts, two in number, consisting of latticed columns which extend to a total height of 40 feet above the molded main deck.

At the bow of the boat is the hoisting frame for the suction ladder, which consists of an A-frame pin-connected to the bow plate with the legs spread 22 feet 8 inches between centers, each leg being constructed as a latticed channel column. The frame is guyed to the head of the swinging frame, which in turn consists of a 10-inch by 25-pound I-beam supported near each end from the main deck by a two-legged frame, each leg consisting of a latticed channel column.

The main deck of the dredge is given over to propelling and dredging machinery, but on the boiler deck, which extends from the stern forward a distance of 124 feet 6 inches, will be found two cabins with an open gangway, 10 feet 6 inches wide, separating them. The forward cabin is 30 feet 4 inches long by 26 feet wide, containing a central hall 11 feet wide with staterooms, bath and wash rooms adjoining it on either side. The forward end of the hull is used as an office and the after portion as an officers' messroom.

In the after cabin, which is 44 feet by 26 feet wide, are located the kitchen, the cook's and laundress' rooms, while the after part is taken up by the crew's messroom and quarters with a waiter's room on the starboard side and a laundry on the port side.

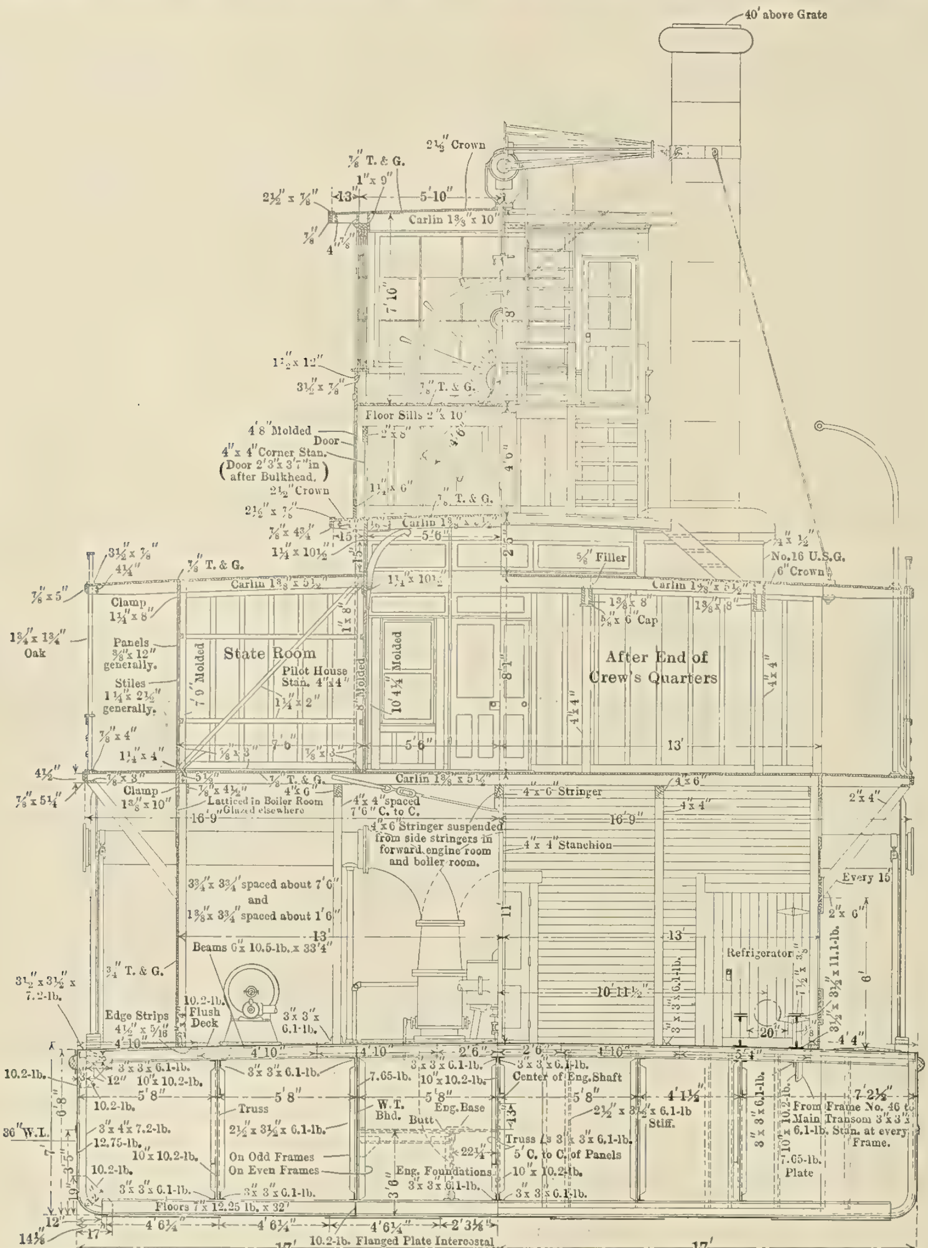
The hurricane deck, which is co-extensive with the boiler deck, contains only the pilot house, which is 12 feet by 11 feet 8 inches wide, located forward on the deck.

PROPELLING MACHINERY

Steam for the propelling and dredging machinery is furnished by two boilers of the Mississippi River type, each 42 inches minimum internal diameter by 28 feet long, with five 9¾-inch flues. The boiler shells and drums are 28/100 inch thick, the flues 25/100 inch thick and the heads ⅝ inch thick. All the longitudinal seams are double riveted and placed above the fire line, while the girth seams are single riveted. The boilers are built for a working gage pressure of 160 pounds per square inch. The single steam drum, which is connected to each boiler by a leg 12 inches diameter, is 8 feet long by 18 inches diameter. There are two mud drums, each 14 inches diameter by 7 feet long, connected to each boiler by a leg 8 inches diameter. Each boiler is equipped with a Snowdon heater, and there is a mechanical draft apparatus for each chimney consisting of a 50-inch full-housed fan with water-cooled bearings guaranteed to deliver 5,000 cubic feet per minute of gases at 550 degrees Fahrenheit with a pressure of one inch of water.

There is also an auxiliary boiler of the vertical submerged flue type, 42 inches diameter, 8 feet high, containing eighty-five 2-inch tubes. This boiler furnishes steam for the deck machinery, engine room auxiliaries and electric light engine.

The main boiler feed pump is a horizontal duplex double-acting pump with steam cylinders 6 inches diameter and water plungers 4 inches diameter with a stroke of 6 inches. The auxiliary boiler feeder is a 7½-inch by 5-inch by 6-inch pump similar to the main boiler feed pump. It will also serve as a general service pump for washing decks, pumping bilge, fire service, etc. There is also a full equipment of donkey, hand, deck and filter pumps with their connections.



Looking Forward at Frame No. 24 Looking Forward at Section 2' Aft of Frame No. 46

FIG. 2.—MIDSHIP SECTION

The main propelling engines consist of a port and starboard cylinder each 13 inches diameter by 6-foot stroke of the usual Mississippi River type, with balanced poppet valves, both steam and exhaust, of the Frisbie type arranged for working full stroke, and also provided with a "California" or "Cross" cut-off adjustable from ⅛ to ⅞ stroke. Each pitman is 25 feet long from center to center of the wrist pins. It is of clear Douglas fir 13 inches deep and 11 inches wide finished dimensions at the mid-length.

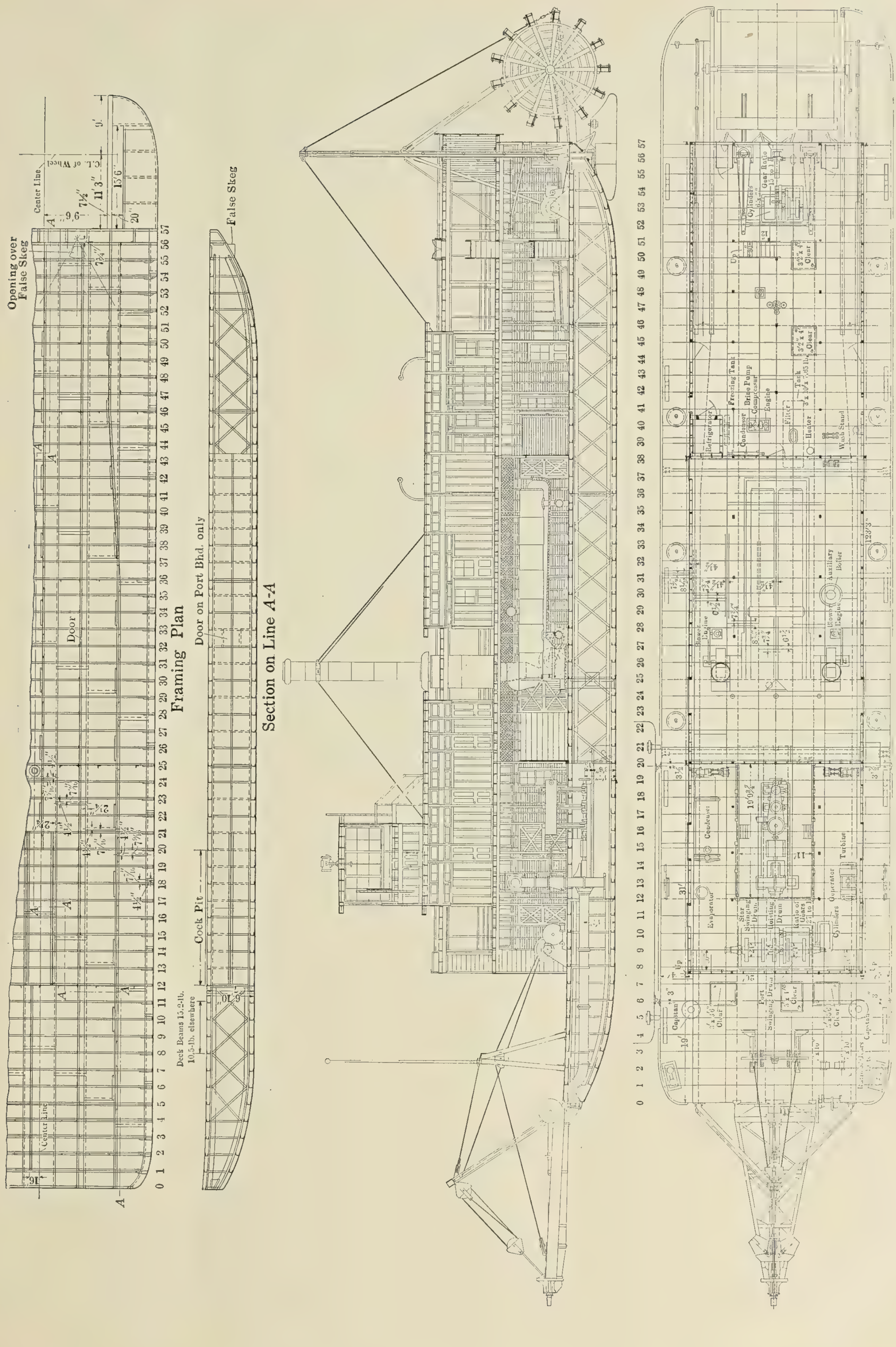


FIG. 3.—FRAMING AND GENERAL ARRANGEMENT PLANS OF THE DREDGE WATERWAY

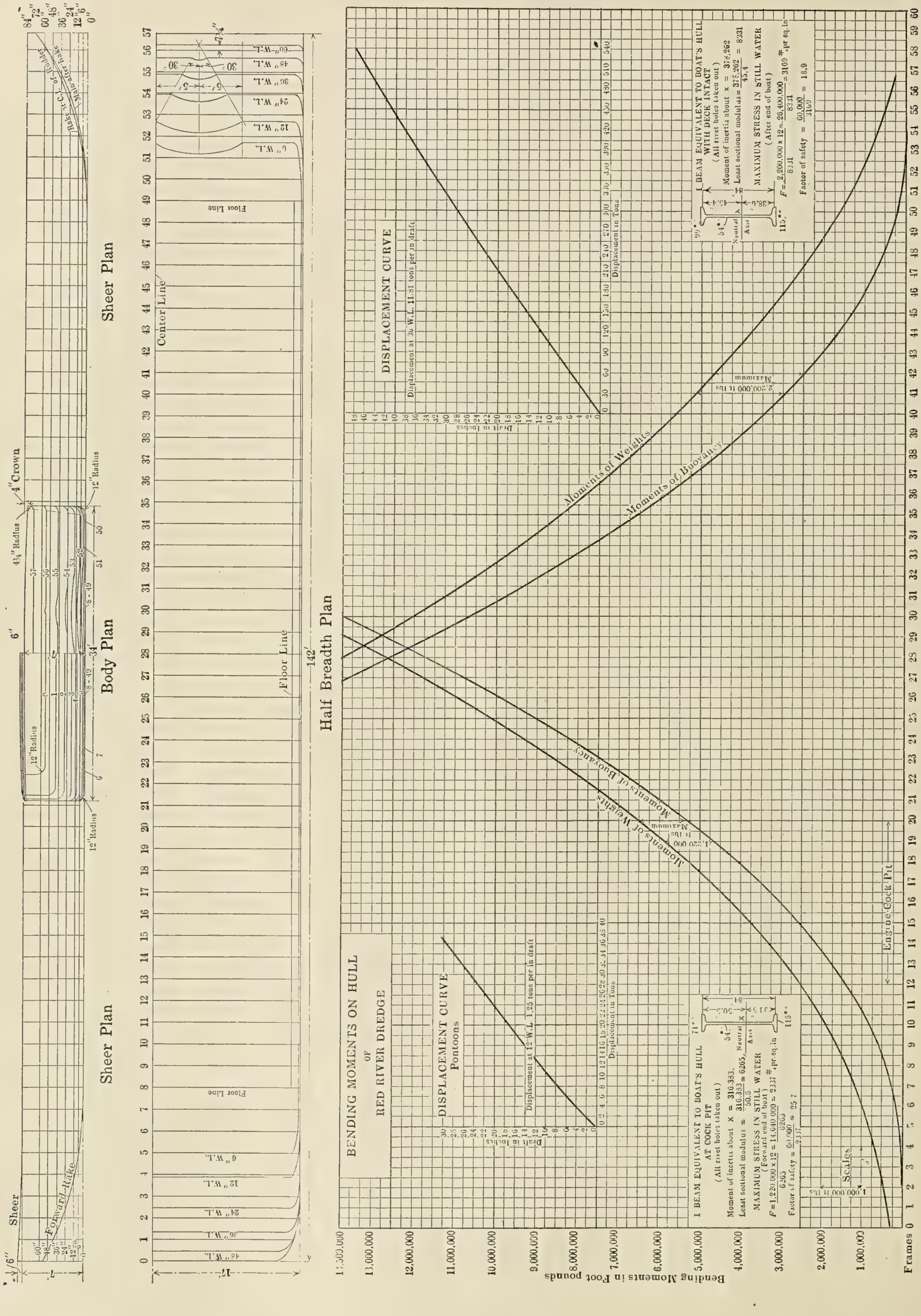


FIG. 4.—LINES AND BENDING MOMENT CURVES OF HULL

The stern paddle wheel is 18 feet diameter over the buckets. There are thirteen buckets, each 18 feet long by 22 inches wide by 1½ inches thick. Four of the buckets are double to balance the cranks. The wheel shaft is solid of hexagonal section with the diameter of the inscribed circle 9 inches.

A refrigerating plant of the ammonia compression type of sufficient capacity to cool a storage room or box of 150 cubic feet internal capacity, and, in addition, to make 300 pounds of ice per twenty-four hours, is located in the engine room. There is also an electric plant consisting of a direct-connected steam turbine and dynamo supplying current for one searchlight, three arc lights and one hundred incandescent lamps.

Dredging Machinery

The main pumping engine is located fore and aft on the center line of the boat in a cockpit in the forward engine room. It is of the marine type indicating 250 horsepower with steam at 160 pounds gage boiler pressure, 24 inches vacuum and 250 revolutions per minute. A steam separator is placed on the steam line to the main pumping engine and a vacuum oil separator is inserted in the exhaust line of the main pumping and propelling engines.

The dredging pump is of the centrifugal type with both suction and discharge 16 inches diameter. The pump is located in the engine cockpit transversely to the center line of the boat. Its intake is on the forward side, and its outlet, which is vertical of the rectangular form, is to the port of the boat's center line. A suction pipe, 16 inches inside diameter, extends on the center line of the boat from the suction pump forward, where it is connected by a radial joint to the suction pipe in the ladder. A reversing cutter engine with two cylinders 7 inches diameter by 10 inches stroke, is coupled at right angles to a common shaft and located on the main deck at the bow. The engine actuates the shaft and cutter head through a train of gearing to a ratio of about 18 revolutions of the engine to 1 of the cutter shaft.

The rest of the dredging machinery consists of a winch for hoisting the head of the suction ladder and for swinging the boat's head through the dredge cut; also a two-cylinder reversing spud hoisting engine. Three steel pontoons, 47 feet 6 inches by 12 feet wide and 3 feet deep, molded dimensions, together with another pontoon of slightly modified design and a complete discharge line, 16 inches diameter, fitted with flexible and sliding joints, complete the dredging equipment.

Twin Screw Shallow Draft Steamer

John I. Thornycroft & Company, Ltd., is building at the Woolston Works, Southampton, a twin-screw shallow draft passenger and cargo steamer of the following leading dimensions:

Length	180 feet.
Beam	27 feet.
Draft	3 feet.

The hull is built of steel, and divided into seven watertight compartments by means of six athwartship bulkheads. Ample space for cargo is provided in the hold, forward and abaft the machinery space, the passenger accommodation being provided on the upper and promenade decks.

The propelling machinery consists of two sets of triple-expansion engines driving tandem twin screws, the latter being housed in tunnels at the stern, this arrangement being adopted in order to reduce the draft to a minimum and to give the screws good protection in shallow water. Steam is provided by a watertube boiler placed in an enclosed stokehold, the boiler being worked under forced draft. The guaranteed speed is 15 knots.

THE NAPARIMA, A TYPICAL SHALLOW-DRAFT, SCREW-PROPELLED STEAMER

On the upper deck forward are four cabins suitable for the officers of the vessel, and on the same deck aft are placed the galley, dining saloon, lavatories, etc. On the promenade deck is a saloon for the passengers, a ladies' room, pantry and additional lavatories. The rudders are worked by a steering engine placed at the after end of the engine room, and controlled by a steering wheel fitted at the forward end of the awning deck.

Two 18-foot lifeboats are provided and slung from davits on each quarter, also four derricks are fitted for handling the cargo.

This vessel will proceed to her destination under her own steam. Temporary wooden bulkheads and a turtle deck are to be fitted in order to ensure her seaworthiness on this ocean trip.

In most respects the vessel is similar to the steamship *Naparima*, built by Messrs, Thornycroft for the same service some years ago, and which is shown in the illustration, but the present boat is considerably larger.

Boats propelled by gasoline (petrol) or petroleum are to be operated on the Moldau and Elbe Rivers to provide a service between Prague, Stechovic and other cities in Bohemia.

An American-Built Shallow Draft Boat for Alaskan Rivers

Situated at the mouth of the Copper River, Alaska, is what is known as the Orca Station of the Northwestern Fisheries Company, of Seattle, Wash. The cannery located at this station secures its principal supply of fish from the flats and shallow waters around the mouth of the river, and in order to transport the fish from the traps and seine boats where caught to the cannery it was necessary to provide a light draft vessel of considerable capacity for this work. Accordingly, plans for such a vessel were made under the directions of Mr. Frank Walker, marine surveyor and engineer, Seattle, Wash., and the contract for the construction of the boat was placed with the Hall Bros. Marine Railway & Shipbuilding Company, Eagle Harbor, Winslow, Wash. The boat is a stern-wheel steamer named the *W. H. Bancroft,* and has the following principal dimensions:

Length of hull, exclusive of wheel housings	111 feet.
Beam, molded	26 feet.
Depth, molded	5 feet 6 inches.

The hull is built of Puget Sound fir except the stem, which is of oak. The scantlings are shown on the drawings in Figs. 1 and 2. The framing, keelsons and general construction of the vessel are heavy, as she has to encounter bad weather around the mouth of the Copper River, where her route covers both open sea as well as river service.

The vessel has five rudders of the usual river boat type, the stocks of the rudders being 4-inch steel and the blades of ¾-inch plate. The combined area of the blades is large, and the rudders are controlled by a powerful hydraulic steering apparatus, since the swift river currents where the vessel plies necessitate quick hauling.

Cargo is carried in the hold abaft the boiler space and on the deck. The cargo space in the hold is ceiled tight and arranged for drainage to the bilge pumps. Deck cargo is carried to the height of the bulwarks as far aft as the engine space, the bulkhead at the forward end of the engine space being made watertight to the height of the bulwark rail, all doors opening to the engine room being entirely above this height. The galley is located at the after end of the engine space, and all living quarters are provided on the cabin deck.

The vessel is propelled by a stern wheel 16 feet 6 inches diameter and 13 feet wide, having sixteen paddles. The main engines have cylinders 11 inches diameter and 60 inches stroke. Steam is exhausted through an independent condenser mounted on a Davidson compound circulating and air pump, which is located on the main deck between the engines. The condenser itself contains 760 square feet of cooling surface. Steam is supplied at a pressure of 200 pounds per square inch from a single boiler of the locomotive type, having a heating surface of 1,836 square feet and a grate area of 54 square feet,

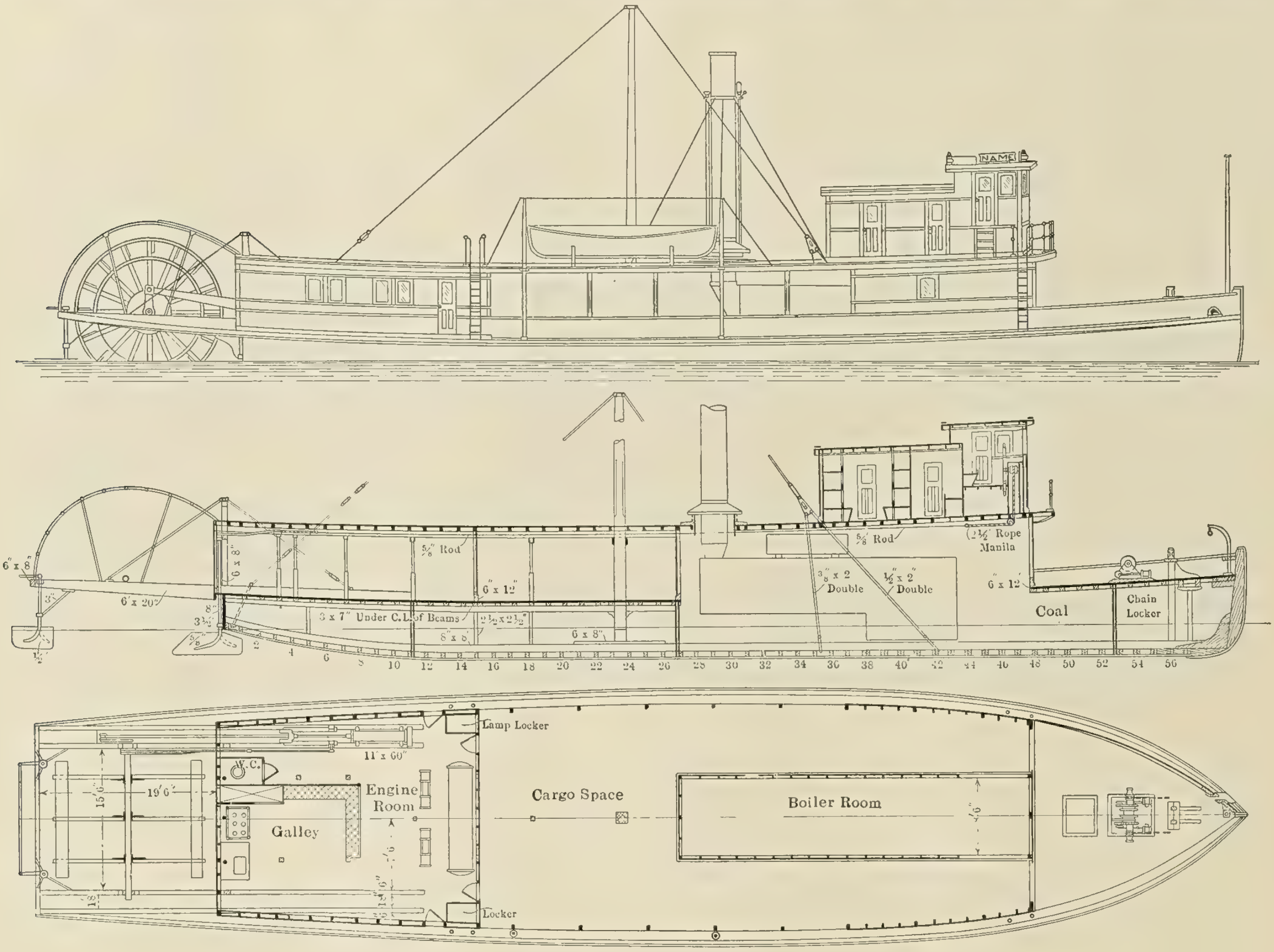


FIG. 1.—OUTBOARD PROFILE, LONGITUDINAL SECTION AND DECK PLAN OF THE W. H. BANCROFT

making a ratio of heating surface to grate area of 32.8 to 1. The fire-room has an ash chute provided with an opening through the bottom of the boat for dumping ashes. The bunker capacity is 15 tons of coal, which gives the boat a steaming radius of 96 hours. The main steam pipe is of copper, 4 inches in diameter from the boiler to the engine room, where it is divided into two branches, each 3 inches diameter, leading to the engines. Two fresh-water tanks, with a combined capacity of 2,400 gallons, are located between bulkheads in the after hold.

The draft of this vessel at launching with the machinery on board was 18 inches. The load draft, with a maximum cargo of 125 tons of fish and with the bunkers full of coal, is 4 feet.

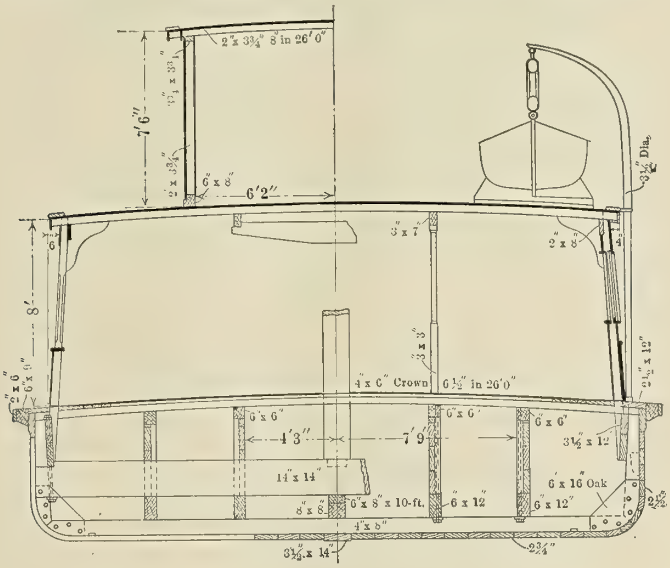


FIG. 2.—MIDSHIP SECTION

The vessel cost complete and ready for service approximately $33,000 (£6,800), and is a staunch and well-built craft throughout. The average speed when light is 10 miles per hour, and when loaded 6 miles per hour.

Another Signal Success for Towing Machines.—The tug Reliance, of the Isthmian Canal Commission (formerly the *M. E. Scully*), completed recently a most remarkable trip. With three barges in tow she left Cristobal on the morning of Feb. 11, and arrived in Panama Bay June 17, via the Straits of Magellan. One hundred and twenty-six days were occupied by the voyage of 10,500 miles. The number of actual steaming days was eighty-six. From Para to Pernambuco, a distance of 1,100 miles, the time was nine days and five hours. The severest weather was encountered during the first three days out, and the heavy seas kept the decks awash. The towing machine at the stern of the tug was often submerged while the bow of the vessel was high in the air. This tug is fitted with a No. 3 Providence Steam Towing Machine of the Shaw & Spiegle pattern, having double cylinders 14 inches in diameter by 14 inches stroke, and using 1,200 feet of 1¾-inch diameter steel wire hawser. Instances have been noted from time to time of steamers taking a single barge in tow from New York to San Francisco, and *vice versa*, and from New York to Liverpool, but this is the first time, we believe, that a tug has ever attempted such a triple tow. It demonstrates the great advantage to be derived from using a towing machine, which relieves the sudden shocks and strains on the hawser so as to prevent the parting of the same, and to enable the tug to proceed in any weather, where it would not be possible to do so were the tow handled in the usual manner, with the manilla hawser and solid tow-posts.

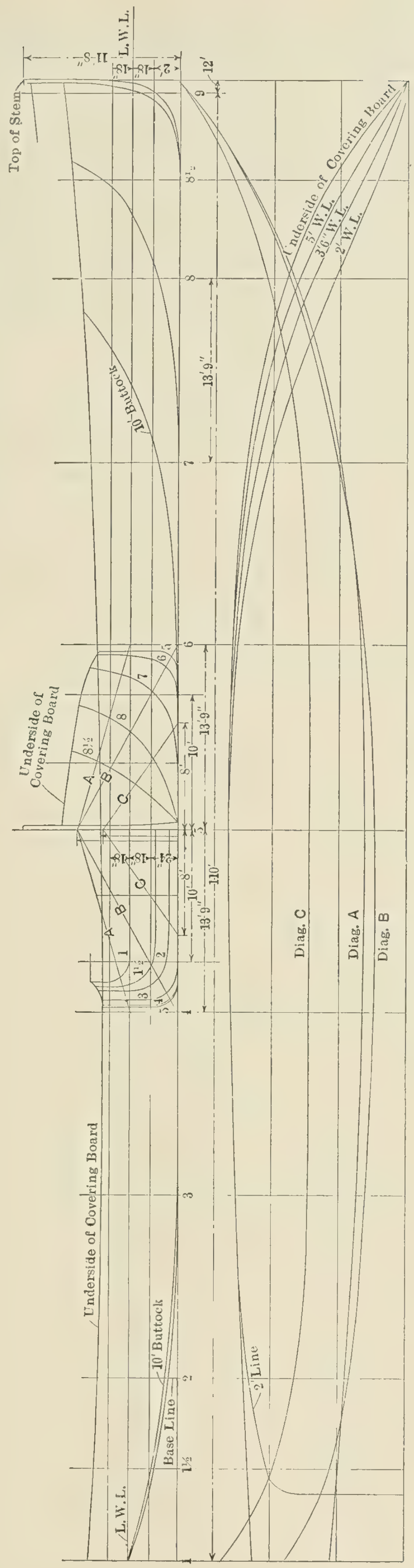


FIG. 3.—SHEER, HALF BREADTH AND BODY PLANS OF THE W. H. BANCROFT

Why Steamboat Traffic Declined Before the Railway*

BY PAUL W. BROWN

The completion of the Northern Pacific and the decline of the steamboat trade on the upper Missouri decided the last great campaign in the contest between the American railway and the American river steamer as means of transportation. What has come to pass since that day has been but a realization of a foregone conclusion. The trade on the lower Mississippi yielded to the inevitable much earlier; its "peak" was touched just at the end of the '50's; it never recovered the disorganization of the Civil War. The decade ending with 1880 saw a heavy traffic on the upper Mississippi; the lumber trade was brisk, and the rush to the Red River wheat country caused the upstream boats to draw deep. The Missouri, with its 2,084 miles of navigable channel, leading to the very gates of the Rocky Mountains, was the last stronghold of river transportation.

Though more than a score of years have passed since the issue was definitely decided, with momentous consequences in the realms of social development, economic progress, finance and even government, no adequate explanation of the victory of the railway over the river carrier has yet appeared. The course of events has been deemed too simple to require extended explanation. Champions of inland waterway navigation and writers on railway development, in polar antagonism on many points, have tacitly agreed that the reason for the decline of river traffic lay on the surface of the event.

When they have proceeded to state that reason, however, they have been far from saying the same thing. There are two standardized explanations of the passing of the steamboat trade, and each is made, with scarce a change of a phrase, many times a year.

The steamboat man and the waterway enthusiast—who, by the way, are not necessarily the same person—assert that it was the total depravity of railway managers which killed the steamboat trade. This is alleged as a sole and sufficient explanation. Steamboat traffic is of necessity limited to certain routes. Railways, we are told, were for years content to do business at a loss on those routes, and recoup themselves by overcharging in districts where there was no waterway competition, in order to strangle the steamboat trade. They gave rebates, issued passes, cut rates, bought up water terminals. They purchased boats, and either laid them up to rot, or made rates so high that no business fell to them. Their work was insidious. When the steamboat owners finally awoke to their danger, the railways were everywhere; their capitalization had reached a figure which made them preponderant in the world of finance; shippers were unable to take the large view, and saw only the free passes and immediate rate concessions held out to them, blind to the coming time when the railway should, like Poe's Red Death on the morning after the feast, "hold illimitable dominion over all." This is the steamboat view.

The railway man, on the other hand, declares that the passing of the steamboat was but the inevitable progress of an outworn instrument of transportation to the evolutional scrap heap. The steamboat season was limited; the railway runs twelve months every year. The steamboat schedule is broken by high water, low water, floating ice, storm; the railway is well-nigh as independent of weather as of season. An upstream freight carrier nets 5 miles an hour; a slow freight train nets 15. Steamboats are confined to certain routes, nearly always circuitous; railways may follow air lines in level country and surmount mountain ranges in that which is rough. Steamboats are restricted to waterside terminals in delivering freight; railway terminals may be as wide as the confines of the community served.

Each of these explanations wins its victory too easily; both are characterized by what John J. Ingalls called "the fatal gift of facility." Waterway explainer and railway explainer have shirked the laborious task of finding out why the steamboat passed away before the railway advance; each has told how the change ought to have occurred.

Now, history manufactured by "the rule of reason" is the least trustworthy commodity known to the commerce of ideas. Actual situations are always more complex than our thoughts about them. Leaving altogether at one side the question why the steamboat ought to have yielded to the railway, why, in fact, did it yield?

The moment we begin to scrutinize the two standardized explanations we are afflicted with certain doubts. The steamboat man's explanation may apply to the final phases of the struggle, but it seems wholly insufficient to account for the railway's initial victories. When the railway first appeared upon the scene, it was the interloper, the untried and unproven instrumentality, while the steamboat held the field. Throughout the river valleys of the West the steamboat interests controlled transportation, and were inextricably interlocked with banking and manufacturing interests. As for total depravity, manifesting itself in rate-cutting and kindred practices, by what Machiavellian stroke did the infant railways possess themselves of all the effective resources of human rascality, and leave the steamboat owners to go to hopeless ruin with clean hands and pure hearts? No explanation of this miracle has ever been tendered, nor am I aware of anything in the history of morals which might help one to understand it.

When we turn to the railway explanation we feel the same dissatisfaction. It is true that the river carrier does not operate throughout the whole year; but the same disability has not prevented the lake carrier from building up a traffic which is one of the wonders of modern transportation. The railway may, within certain broad limits, go where it pleases and deliver goods where they are desired; but the infant railway competed for business in a world organized for steamboat traffic, with waterside warehouses and factories. Steamboats are much slower than fast freight trains, but in the years of the railway's initial victories over the steamboat our modern high-pressure system of distribution had not been organized, and was not even dreamed of. Shoes were made by hand; packing-house products were unknown outside of a few large centers; harness, wagons, buggies were made in small shops in every village; bananas and oranges were unfamiliar delicacies to the average American. We cannot account for the early triumphs of the railway by invoking its supply of needs which had not then been created.

When we consider the main contention of the railway view—that the steamboat was brushed aside before a more economical means of transportation—we are confronted by the incontestable fact that it has not been brushed aside. Small as is the volume of steamboat traffic, it still continues, and not simply with districts not readily accessible by rail, like the projecting tongue of land between the Mississippi and Illinois. The steamboat survives in highly competitive territory. St. Louis and Alton are connected by railways and by a fast interurban trolley line; yet packet boats, carrying both freight and passengers, carry on a trade which flourishes in the teeth of

* From the Railway Age Gazette.

this double competition. The Lee Line runs steamers between Memphis and St. Louis, Memphis and Vicksburg, and Memphis and Cincinnati, in competition with great railway systems operating through a country whose climate and topography are especially favorable for economical railway operation. The single instance of this company, with its record of continuous operation for more than a generation between chief commercial centers of the central west, is proof conclusive that the explanation of the passing of the steamboat must be sought in something more convincing than an easy generalization about "an outworn instrument of transportation."

The full explanation is not all to be found in any one place. The portions of it which I have gathered have been encountered in many places; in conversations with old merchants in little waterside towns, and with old pilots on hills overlooking long reaches of empty river; in stray remarks dropped in pilot-houses, as a laden packet went swinging down the long curve under the high bank of a great bend on a summer night; from dusty files of newspapers of the '50's; out of observation of the actual operation of steamboats on many waters at the present day. The main factors of the decline of the steamboat trade in the face of railway advance were:

Instability of rates.

Uncertainty and irregularity of service other than those occasioned by the shortness and variable length of the river season and the ordinary hazards of navigation.

The short life of the individual steamboat.

The nuisance of marine insurance.

The lack of effective line organization.

The habit of extravagance engendered by an era in which the westward advance of population was out of all proportion to the capacity of existing means of transportation.

The first two points—instability of rates and irregularity of service other than that inseparable from the conditions of steamboat operation—are so intimately related that they may most conveniently be considered together.

In the golden days of steamboating there was not a stable rate in all the vast region lying between Fort Benton, Mont., and Pittsburgh, Pa. Each steamboat was an independent traffic unit; the captain was his own freight and passenger association, classification committee, and general passenger and freight agent. In New Orleans in the greatest year river trade ever saw—the season ending August 31, 1860—the average cargo of the 4,030 steamboats tieing up at the levee was 540 tons; at St. Louis, eighteen years before, the average cargo of the 2,412 arrivals was 193 tons. It is not too much to say that there were as many "adjustments" of rates as there were arrivals, for while occasionally two or three boats might load side by side at identical rates, more often the captain of a steamboat that was loading found it either necessary to "shade" his figures to complete his cargo, or possibly to raise them as the available stowage space grew smaller, in view of an empty river and a full wharf.

A single instance will mirror the situation. Missouri City, on the north bank of the Missouri River, 28 miles below Kansas City, was once an important shipping point for a wide hinterland. "When boats were plenty at the season of high water," said an old shipping merchant, "the St. Louis rate would go down to 25 cents (1s. ½d.); when the low water season came on and boats were scarce, it sometimes reached $2.50 (10s. 5d.). Passenger rates varied from $10 to $25 (£2 1s. 8d. to £5 4s. 2d.) for the same reason."

An incident of those days rounds out the picture. "I remember," said the Old Timer, "once Jim Lane sold some tobacco to the government. The water was low, and Jim was mighty anxious to get it started towards Fort Leavenworth. Well, the *Annie Jacobs*, Captain Bill Massie, come along, loaded so's she was drawin' all the water they was in the river, but pretty well down by the head, so if she got her nose over a bar, the rest'd be pretty sure to follow. 'Take my tobacco?' says Jim. 'Not on yer life,' says Bill Massie. Jim begged and begged, but 'twa'n't no use. Finally he says: 'Cap,' says he, 'if you'll jest put that tobacco aboard, and start her up river, I'll pay ye the full rate, and give ye the best suit o' clothes that a $100 bill 'll buy in St. Louis.' So Bill he took the tobacco." It is needless to remind the reader either that the Elkins law slumbered in the bosom of the unrevealed future at this time, or that interesting statute has never been construed to apply to steamboats.

Late in November, 1852, just at the end of the season, the *Excelsior* arrived in St. Paul from St. Louis with 300 tons of freight for which she had received "one dollar (4s. 2d.) a hundred any distance."

Coupled with fluctuations in rates which mounted to 1,000 percent of the minimum there was great irregularity of service, owing to the fact that the individual steamboat did not, for the most part, develop a trade and stick to it, but went where the returns were greatest. The Western "steamboat country" extended from St. Paul to the Gulf, and from the heart of the Southern Appalachians and the headwaters of the Allegheny to the foothills of the Rockies in Montana. Times might be dull on the Tennessee and good on the Oauchita; the Minnesota river trade might boom just at the time when crops had failed on the Osage and the Gasconade. What happened then? A steamboat which had made regular trips to certain landings for two or three seasons might enter trade simply by hiring a new pilot, or instructing the old one, if his license covered the new territory, to turn the boat's head in that direction. The freight at the old landings would wait in vain; it might rot, or find some other conveyance. Nothing bound the vagrant steamer to her old trade, as the sound of her deep breathing grew fainter in the distance, and the white water from her paddles blended indistinguishably with the turbid river. This tendency of the steamboat, without warning to the shipper, to deprive him of his accustomed means of transportation just at the season of his greatest need—the time of crop failure, or of slow transit, because of low water—was one of the prime uncertainties of business "when the steamboat was king." Trade can adjust itself to a limited shipping season; the hazards of high and low water follow, usually, a certain cycle, and may be in a general way foreseen. But the steamboat that departed for more crowded landings just at the time when an established trade most needed regular service, introduced into business a hazard of the first order.

What was the effect of these fluctuations in rates and uncertainties of service on the competition of rail transit with the river trade?

While there are, of course, factors making for variability in rail rates, they are few and feeble compared with those which influenced river rates in the olden days. The river is an open highway; any man who could command $20,000 (£4,110) could build and pay for a small sternwheel boat and become a factor in rate making; the railway is an artificial traffic way and requires a heavy initial investment before equipment is purchased and operations begin. The costs of river transportation as carried on in the '50's were only interest on cost of equipment, depreciation of equipment, wharfage charges, fuel and boat supplies, and wages of crew. To run a railway requires a large and permanent organization—engineers, section men, bridge men, station agents, despatchers and signal men, yard and roundhouse crews, a traffic staff, etc.—in addition to the crews operating the trains. All this fixed expense tended inevitably toward stability of rates. Then, too, the climatic factor, while affecting the railways to some extent, is negligible in rate making. Times of high water may cause

an occasional washout on a railway, but that is all; while the season of low water does not exist for railway operation. A railway knows delay on account of storms, but it is but an incident of the day's work. In the steamboat trade, on the other hand, low water greatly increases operating expense, while high water makes certain landings inaccessible, and opens up some areas of traffic which are closed at ordinary stages. All these are real and vital factors in the making of rates.

Still another thing must be taken into consideration: the size of the unit of equipment. A railway train is elastic, and is an aggregation of traffic units containing, in the early days, about 8 or 10 tons each. The steamboat with which they competed had a fixed capacity averaging as much as two 20-car railway trains. Full or empty, the downstream expense was practically the same, and the upstream cost nearly so. After a boat had secured cargo enough to meet her fixed and operating expenses, all that came to her in addition, at any rate greater than the expense of setting it on and off, was so much clear gain. If the freight trains of that day had a fixed length of 20 cars, railway rates would have had an additional element of instability.

But in the matter of service, the great advantage of the railway over the steamboat was that the grade was not portable and the rails spiked down. The railway stayed when the steamboat went—not because the railway man was wiser than the steamboat man, not because he would not have been glad to move his road, when times were dull at home, to lead into the Red River Valley, or to the mines of Montana, but simply because it couldn't get away. Before long, the railway man began to see his opportunity in the steamboat man's desertion of his territory. *The railway intrenched itself as an instrument of transportation in the lean years, when the steamboat had departed for other valleys, where the hills were green afar off.*

Now it is an axiom of the transportation business that any rate is better than an uncertain rate. When this is reinforced by the further axiom that a certain means of transportation has an infinite advantage over an uncertain one, it will be understood why the shipper "signed up" with the station agent after the steamboat had left his goods, literally high and dry, in his hour of need, and paid a somewhat higher rate for a definite service. The shipper was willing to wait for the *Prairie Belle* when the river was low, and to lay in a stock in the fall to "run him through" till spring; but when the captain of the *Belle* left the Illinois river to go to the Yellowstone without sending him word, and he let the *Evening Star* go by because he was saving his apples for the other boat, thus losing a dollar a barrel in the St. Louis market, he vowed vengeance, and went in quest of the railway station agent.

The life of the wooden steamboat is short. The *Western Boatman* for 1848 presented an estimate of the total number of steamboat "fatalities" up to that time, with an analysis of causes. The conclusion was that the average age of boats "worn out or abandoned" was five years, and that of those "sunk, burnt or otherwise lost" was "four years, or nearly four." In the ten years between 1840 and 1850 there were 270 boats lost in Western waters. Forty boats lost their lives by snags in 1840, according to Gould's "History of River Navigation," and 29 in the year following. George B. Merrick, the historian of steamboating on the upper Mississippi, has compiled records, as far as possible, of every boat which ever ran regularly above the Upper (Rock Island) Rapids. Their average life was five years. The most prosperous year on the Lower River, 1860, saw 290 boats destroyed or damaged; 120 of these were totally destroyed.

It is interesting to compare these figures with the number of steamboat arrivals at New Orleans, the great entrepôt of the valley. These totaled 4,030. The casualty list, of course, includes all Western waters, but it is suggestive that if the boats reaching New Orleans averaged but ten trips each in the season—which is twelve months long on the Lower River—the fleet numbered but 403; and that the number of casualties in the Valley resulting in total loss was about one-third as great as the whole New Orleans fleet.

The average life of the boats worn out in service seems very short. We shall return to that point later. It should be remembered here that average means average. There were boats which remained in service for twenty years, like the *Itasca*, built in 1857 and burned at La Crosse in 1878; but there were others which never completed the first trip.

Now, the short life of the steamboat had a very definite influence in its contest with the railway, entirely apart from the question of hazard. A railway is, physically, a resistant thing, and a dull season perhaps has as great a tendency to lengthen the life of rails and equipment as to shorten it. But the causes which operated to produce a dull year in the steamboat trade—crop failure and consequent paralysis of business—brought about also a stage of water that greatly increased the hazards of operating wooden boats. Then, too, it must be remembered that the prosperous boat owner who became a trifle lazy and stopped building boats, though he might continue to operate all he had, would, in the course of a very few years, go out of the business automatically. A railway, short of bankrupt sale, remains, for better or for worse, in the hands of its owners; a fleet of wooden steamboats, no matter how well operated, if not reinforced by frequent additions, literally disappears from sight in the course of a few years and "leaves not a wrack behind."

The nuisance of marine insurance was a factor in the decline of the steamboat trade which may be summarily disposed of. For some inscrutable reason, steamboat men have never learned to deal with the insurance brokers themselves, and issue an insured bill of lading. After the shipper has obtained a satisfactory rate, he must visit the broker himself, and get his insurance. Nor is the insurance full; it covers only damage in transit; goods at the landing are at the shippers' risk. Even though freight rate and insurance rate added together leave a comfortable margin below the rail rate, there are the human factors of worry and trouble, and the commercial factor of time lost over negotiations.

Before we begin to consider the effect on the steamboat trade of absence of adequate line organization, I wish to revert to the important fact that the victory over the steamboat was won, not by the railway of the present day, but by the railway as it was in the Mississippi Valley between 1860 and 1880. When the steamboat man of the present day talks of the change that has come over his calling, he accounts for it by experiences of the past twenty-five years, the darkening twilight period since the setting of the steamboat sun. When the railway man of the present day pauses to account for railway supremacy, he unconsciously thinks in terms of the modern railway. Now, let us recognize, once for all, that the railway that won a victory over the steamboat knew nothing of continuous brakes on freight trains; that its freight cars carried from 16,000 to 28,000 pounds each, instead of from 60,000 to 110,000; that 38 tons was, in the Mississippi Valley, a heavy locomotive; that rails were largely of iron, perhaps 40 pounds in weight on the average; that block signals, gravity terminals, automatic couplers, steel underframing and draft rig were as far from the vision of the railway man as were concrete bridges and culverts, 100-pound rails, ½ percent grades through rough country, compound engines and superheated steam. The steamboat of fifty years ago was every bit as good as the steamboat of the present day; the record time between New Orleans and St. Louis was

probably made by the *J. M. White* in 1844 (the *Robert E. Lee*, in 1870, finished in less time than the *White*, but the river had materially shortened itself by cut-offs in the intervals). The railway has gone on; the steamboat has stood still.

It is very easy to draw the wrong inference from this fact. The hasty generalizer will jump to the conclusion that if the steamboat retired before railways so imperfect it is evidence of its utter worthlessness in the modern transportation world. Let me once more remind him of the boats now in operation in highly competitive territory, and advance, tentatively, the view that the conclusion to be drawn is rather that factors other than the straight economic test of two rival instruments of transportation are to be invoked in the explanation.

This is especially to be remembered when we take up the absence of adequate line organization, and its effect on the steamboat's fate.

The great magnitude of American commercial corporations, that most significant fact of our modern commercial life, with its marked effects on social organization and even on national character, is the direct result of necessities laid upon American railway managers by the continental sweep of American territory. The first big American corporation was the railway corporation, and it became big because of the breadth of its necessary field of operation. In England there is no town or village situated more than 90 miles from a seaport. In France the greatest distance from the seaboard is little more than twice as much. In the United States the goods which, at Buffalo, reach the eastern limit of Lake navigation after a journey of 1,000 miles, are still 400 miles from the seaboard. In 1843 the traveler could go by rail from Buffalo to Albany, but he was carried on the rails of sixteen different companies. The business was largely through business. It traversed a territory under one government, with one language, one law and one tradition. That these sixteen companies, each by a link in one haul, should coalesce and become one was inevitable. It was but response to the compulsion of inexorable necessity.

All over the United States the same process was going on. The world had never seen such corporations. Mankind had never extended so far the bounds of a single commercial management. But the continent was inexorable. It was the continent that compelled the American railway manager to stretch his conceptions to its imperial extent, to think in terms of its vastness, to run one railway from the sea to the Lakes, and from the central river to the western sea. The early railway managers made mistakes. They tried to apply to corporations gigantic beyond precedent means of control inadequate to such vast creations. Some of them were devoured by their own Frankensteins. But the length of the railway was dictated by necessity. The road had to run to the land's end.

The steamboat man saw this, and tried to meet combination with combination. He failed. The reason is clear. He was not coerced by necessity. Between St. Louis and New Orleans one captain and crew, with a $40,000 (£8,220) boat, was as complete an instrument of transportation as the Illinois Central Railroad—of far less capacity, but equally sufficient unto itself.

The human factor is tremendously important here. The steamboat, in 1860, had been the chief means of transportation in the West for forty years. It was then as old as the railway was in 1894, forty years after the first line touched the Mississippi. The best human material had gone into the business. Now, the steamboat man was an individual pure and simple. The captain made his own schedule, selected his own route, accepted or rejected freight consignments, as his judgment dictated. He often owned his own boat; how often one must pore over old steamboat lists to realize. If he worked for other owners, they trusted him in everything, so long as the returns of the trade were satisfactory. He penetrated new countries. He braved hostile Indians. At each end of the season, in the North, his boat played a game with death as he dared the ice, for there were rich rewards for the last boat into St. Paul, and the first to leave St. Louis or Dunleigh (East Dubuque) in the spring.

One thing this admirable and capable individual did not understand—how to work in harness. This is the first lesson the railway teaches, for obvious reasons. It is, in the end, the great lesson of civilization's riper pages. The steamboat captain lived and died a pioneer. And when the transportation business reached the stage where organization on a large scale was a determining factor, the railway found itself with a personnel trained to pull together and move at the word of command, while the steamboat trade was manned by a splendid set of individual chieftains, undisciplinable, unorganizable, each ready to go down to the bottom of the river, if necessary, with his own particular pennant nailed to his own particular jackstaff.

The Rock Island tapped the Mississippi in 1854. Within two years thereafter the railway reached the river crossings at Galena, Alton, Burlington, Quincy and Cairo, and the railway became a factor in the steamboat world. The first joint stock company for the operation of steamboats in Western waters was the "Cincinnati and Louisville Mail Line," organized in 1818. The first regularly organized company in the Upper Mississippi was formed in 1842. It was not until just after the Civil War that this form of organization was tried out on the Missouri. Many of the so-called "lines" were simply operating pools. Each captain owned his own boat and could retire with his share of the profits or losses at any time. The instability of such an organization at just those times when organization was most vital to the life of the trade needs no comment.

A few brief biographies of lines, real and so-called, will reveal the actual course of events better than general statements. In 1858 the "Railroad Line," having traffic arrangements with the Illinois Central at Cairo, and the Ohio and Mississippi at St. Louis, was formed by the owners of ten of the finest steamers in Western waters to run between St. Louis and New Orleans. "While this was not a joint stock company, the boats were run in joint interest, and with a regularity heretofore unknown in this trade and at uniform prices for the business they did." The traffic man will read much between the lines of this naive comment of Captain Gould, vessel master and historian of steamboating. Soon the new line, which included the *Pennsylvania* and the *Alex. Scott*, was high in favor with shippers and passengers. "A position in the 'Railroad Line,' or a 'day in the line,' as it was called, was coveted by all who had a boat suitable for the trade, and commanded a large premium when offered for sale, and as high as $1,500 (£308) was paid in some instances." This line was broken up by the Civil War.

Just after the war, in the prostration following the destruction of southern trade and the disuse of army transports, a large joint stock company, the "Atlantic and Mississippi Steamship Company," was formed by steamboat owners, who took stock according to the appraised value of the boats they put into the line. The capital was $2,000,000 (£411,000). The line had through billing arrangements with railways and ocean-going lines. This venture was killed by the individualism of the steamboat men, both without the line and within it. The owners who were left out of the new organization combined at once and disorganized the rate situation by competition. The effects of this spirit within the line are eloquently summed up by Captain Gould. "Many of the steamboats were in commission, manned by crews with little [pecuniary] interest beyond their salaries, each crew striving to excel the

other in the excellence and luxury of their tables and the speed of their boats, with no one to control or check their extravagance.'"

A lurid light is cast upon the central organization of a corporation the aggregate of whose property was "fabulous" to the chronicler. "The widespreading limits of the company's business rendered it impossible for the executive officers (only two of whom were receiving salaries) to do more than give general supervision, leaving the detail and the result to the judgment and the caprice of those in charge of the boats." Discipline in the general sense there was none, and discipline on the individual boat appears to have gone by the board, for a series of disasters swept away half the fleet in six months. The line lasted less than two years. We read that "the directors were liberal, high-toned business men, and stood manfully by the company throughout all its embarrassments."

It is worth while to remark again that these were the best boats, officered by the best boatmen in the Valley. This single history is conclusive as to the fitness of the pioneer steamboatman to "work in harness."

All other forces making for the decline of the steamboat trade were intensified in destructive quality by the general social situation in the forty years intervening between 1850 and 1890. This was a time when a tremendous population movement overflowed utterly inadequate channels of transportation. All the steamboatman's other disabilities might have been overcome had he been in any true sense a sane business man.. He was the spoiled darling of fortune. The whole course of social development was such as to beget in him habits of extravagance, and to make him trust that the morrow would care for the things of itself. The steamboat, during the years between the building of the first railroad to the Mississippi and the completion of the Northern Pacific, which killed the trade between St. Louis and the Upper Missouri, was not, like the railways of the present day, the medium of the interchanges of a settled population. It was the vehicle of the advance of an eager population into a virgin land. The '40's and '50's saw the rush to Wisconsin and Minnesota; the period following the war witnessed the conquest of the Red River wheat country by immigrants by the Missouri and the Red River of the north. Then came the discovery of El Dorados on the headwaters of the Missouri, beyond the end of its 2,084-mile steamboat journey from St. Louis.

"Many a time during the Minnesota rush," said an old pilot to me, "the captain has watched the people coming on the boat at Dunleith or Rock Island until she had all she'd sleep on the cabin floor and the boiler deck, besides two in every bunk and steerage passengers all over the freight on the main deck. When he guessed she had all she'd take, he and I would take the sounding pole and walk down the landing-stage, crowding back the people who were pouring on in a steady stream. Then we'd cast off and straighten up, with the levee as crowded, to the eye, as when we come in."

It was the demand for transportation thus created—and the incident given above could be paralleled many times in every "trade" of that day—that was at the root of all the steamboat's disabilities. It was responsible for the fantastic variations in rates; it was responsible for the desertion of established routes by captains, lured by the great rewards of pioneering. The short life of the steamboat would have lengthened, as improvements strengthened its weak places, substituted steel for wood, and differentiated passenger and freight carriers, just as has happened in Europe; but what was the use? When a good boat would pay for herself in one season and could reasonably be expected to last five, why worry over steel hulls and cargo-box barges? Suppose the shipper did find himself incommoded by the necessity of bargaining with the insurance broker; who cared, when there was more freight as it was than the boat could load? Suppose the line went to pieces; the captain of the *Nancy Belle* held a license covering the Missouri, and passengers were plenty at St. Louis with $300 (£62) each to pay for transportation to Fort Benton. Pilots were paid regularly $500 (£103) a month; crack men received much more. One pilot, paid by the trip, who had an especially good knowledge of the eccentricities of the Missouri, made $120 (£25) a day between Kansas City and Omaha. Captain "Bill" Massie "cleaned up" more than $30,000 (£6,160) in a single season on the Missouri at the wheel.

When the West and North became populated this transportation fever went down. It left the steamboatman with an empty pocketbook—for his prodigality had equaled his earning power—expensive tastes and invincible prejudices in favor of the business methods of a boom period.

The foregoing were, in my opinion, the chief causes of the decline of the river trade in the West. The causes usually alleged by critics of the railways certainly operated and go far to explain how the rail lines, grown strong and conscious of their strength, took away the remnant of the kingdom of the steamboat. But this is not the real problem; that is set for us by the earlier years, when the railway was crude and its service imperfect, when accidents were many and schedules represented only the substance of things hoped for, while the steamboat was the accepted means of transportation in a traffic world organized by and for water carriage. The victory of the railway was not a matter either of swiftness of transit or ton-mile costs. The question of the relative economy of the two instruments of transportation in the Mississippi Valley has yet to be tried out in a practical way.

Naval Architects' Meeting

The twentieth general meeting of the Society of Naval Architects and Marine Engineers will be held in the Engineering Societies building, New York, Thursday and Friday, Nov. 21 and 22, each session beginning at 10 A. M. The Council will meet at 3 o'clock Wednesday, Nov. 20, in the Engineering Societies building, and proposals for membership should be mailed so as to reach the secretary on or before that date. The annual banquet will be held in the Astor Gallery of the Waldorf-Astoria at 7 P. M., Friday, Nov. 22.

A preliminary list of papers to be read at this meeting is as follows:

November 21

1. "Experiments on the Fulton," by Professor C. H. Peabody, Member of Council.
2. "The Design and New Construction Division of the Bureau of Construction and Repair, Navy Department," by Naval Constructor R. H. Robinson, U. S. N. Member.
3. "Engineering Progress in the U. S. Navy," by Captain G. W. Dyson, U. S. N.
4. "Marine Lighting Equipment of the Panama Canal," by Mr. James Pattison.
5. "The Lightship," by Mr. George C. Cook.
6. "Oil-fired Marine Boilers," by Mr. E. H. Peabody, Member.
7. "The Preservation of the Metals Used in Marine Construction," by Lieut. Commander Frank Lyon, U. S. N.

November 22

8. "An Electrically Propelled Fireproof Passenger Steamer," by Mr. W. T. Donnelly and Mr. G. A. Orrok, Members.
9. "Notes on Fuel Economy as Influenced by Ship Design," by E. H. Rigg, Member.
10. "Different Applications of the Marine Gyro in Science," by Mr. Elmer A. Sperry, Member.
11. "Rudder Trials of the U. S. S. Sterett," by Asst. Naval Constructors R. T. Hanson, U. S. N., and J. C. Hunsaker, U. S. N., Juniors.
12. "Logarithmic Speed Power Diagram," by Mr. Thomas M. Gunn.

Papers are also contemplated on "Recent Developments of the Marine Diesel Engine" and the "Development of the Hydro-Aeroplane," subjects which are of particular importance at the present time, and which it is hoped will be thoroughly discussed at this meeting.

Water Transportation, Rail Rates and the Inter-State Commerce Commission

BY JOHN RUDDLE* .

The great agitation that has taken place within the last few years and the great expenditure of money that has been made by the Federal Government on improving waterways for navigation, warrants the assumption that it is the policy of the United States to encourage the development of internal water-borne commerce—whether for the purpose of assisting in the regulation of railroad rates or for the sake of the water traffic itself is aside from the question—the policy seems to be established. But in all the discussion the method of regulating the competition between the water carriers and the railroads seems to have been overlooked, or at least has received very little discussion.

In European countries it was discovered very early in the development of railroads that it would be necessary to protect the commerce carried by water from destructive competition from them or it would be destroyed. It was comparatively easy to establish this protection and to make it effective, because the railroads and waterways are very largely owned by the governments, and all that was necessary was to establish rules in making rates that the rate by the railroad should be higher than by water, and they could be easily enforced. Moreover, the public had long been accustomed to transportation by water, and had located their industries so that advantage could be taken of it, and they were naturally very much opposed to having these industries interfered with or made less profitable by the railroads making more favorable rates to the industries that were not so located or could not be reached by waterways; consequently they looked with favor on a differential in favor of the waterways, and it was easy to establish and enforce.

It would be impossible, and even if possible it would be very undesirable, for the United States to follow in the footsteps of the European countries, in order to build up water transportation and fix any arbitrary differential between the rates for water and for rail transportation. In the United States, however, the conditions are radically different. Here the railroad development came first over a very large portion of the country, and industries are located with reference to transportation by them, the water transportation is only now following. Moreover, the railroads are all owned by private capital, and the savings of the people are very largely invested in their securities. Up to the time the Inter-State Commerce Law was made effective the railroads had it in their power to make such rates as pleased their managements, and when in competition for business carried by waterways frequently made rates sufficiently low enough to take all the business away from them and destroy them, and after their destruction raised the rates again not only to the old figure but sufficiently above to recoup themselves for the losses incurred in destroying the water competition. The Inter-State Commerce Law puts in the power of the Commission to regulate the railroad rates and to protect the water traffic from this destructive competition; but, unfortunately, it has not always been so administered, and the water traffic is little, if any, better off than it was before the passage of the law.

As is well known, Section 4 of this act contains a provision known as the "long and short haul clause," which provides "That it shall be unlawful for any common carrier subject to the provisions of this act to charge or receive any greater compensation in the aggregate for the transportation of passengers or a like kind of property, *under substantially similar circumstances and conditions*, for a shorter than for a longer distance over the same line." * * * "Provided, however, that upon application to the Commission" * * * "such common carrier may, in special cases, after investigation by the Commission, be authorized to charge less for the longer than for the shorter distances." The railroads have taken advantage of the phrase "substantially similar circumstances and conditions" to claim the right, under the provision, to make low rates to meet the water competition existing or potential, and their contention has been recognized by the Commission, and the right to make lower rates for the longer than for the shorter haul has been granted. Some of these rates thus made have been unprofitable, and usually, if the water competition was destroyed, the rates were put back to what they originally were or higher. Also the railroads, in order to recoup themselves for the losses incurred under the low rates, made and maintained unduly high rates between points that could not be reached by water transportation, thus placing such points at a disadvantage.

An effort has been made by a recent amendment to the act to prevent the railroads from increasing their rates after they had once been lowered to meet water competition, unless some reason other than the disappearance of such water transportation shall be shown. This, however, is no protection to the water transportation; in fact, it only serves to make more certain that it will not be revived. The application of the law first destroys the water competition and then makes sure that it will stay destroyed by preventing the railroads from increasing their rates to such a point that water transportation would again become profitable.

The following principles of economics will probably be admitted:

1. The body politic has a right to receive from its servants satisfactory service at the lowest cost consistent with such service, all things being considered.

2. If one portion of the body politic receives a service at a cost lower than the actual cost of performing such service some other portion must be charged a higher rate for its service in order to make up the deficiency.

3. No portion of the body politic has a right to receive a service at a cost lower than the actual cost of performing such service.

4. If water transportation cannot perform satisfactory service at a rate equal to or less than the cost to the railroads, it is not entitled to special protection, for the body politic cannot, in the long run, support uneconomical servants.

Specifically, if a railroad makes a rate for transportation at less than the actual cost of performing the service in one territory, in order to compete with water transportation, it must make up the deficiency by charging an excessive rate in some other territory where such competition does not exist.

The above principles might be easily applied in regulating the rates made by the railroad companies, in competition with water carriers, by changing the administration of the "long and short haul clause," and do strict justice to all interests concerned. It is not necessary to amend the Inter-State Commerce Law in any particular in order to permit the application.

In order to apply these principles it is necessary to have

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some figures of cost to start from, and the foundation on which to base these is already available in the reports now made to the Inter-State Commerce Commission. It is not necessary to disturb the present rate fabric in any way.

The cost of performing service by a railroad is made up of two items, "operating expenses" and "fixed charges"—this latter including interest, taxes and all expenses aside from the expenses of operation and maintenance. These expenses cannot be sub-divided so as to determine exactly what portion should be charged against any particular class of traffic, as, for instance, between freight and passenger traffic, and consequently no absolutely accurate figure to represent the cost of performing the freight service per unit can be determined, but it is not necessary so long as the same method is followed in all cases.

As at present rendered the accounts show costs and receipts of operation in units of "passenger miles" and "ton miles." A third unit might be adopted called the "general unit mile," or simply "unit mile," made up in the following way: Assume for the purpose of this unit that passenger miles and ton miles are the same kind, add them together and divide into the total of fixed charges to get a "general unit" overhead charge. Determine the relative percentages of the passenger miles and the ton miles to this sum, and multiply the "general unit" by the percentage of the ton miles to get the proportion that belongs to the freight traffic. Add this to the ton-mile cost of operation to get a total cost per ton mile for freight traffic, which will have to be the absolute minimum that can be received for services if the company is to continue solvent. In a similar manner the general unit-mile revenue can be determined, and the difference between them will show what will go to the stockholders or be available for improvements. This total cost per ton mile will then furnish a base from which the principles already stated can be applied.

When a railroad comes to the Commission with an application for permission to make a rate, using as an argument that it is asked in order to meet water competition, it should be required also to show the mileage over which the rate is to be operative and the subdivisions of the rate, if two or more roads are interested, or if part of the route is via a water carrier. The rate per ton mile should be determined from these figures for each of the railroads interested. If this rate per ton mile should prove less for each road concerned than the total cost per ton mile as above determined, the rate should be refused unless some strong specific reasons, other than the meeting of water competition, applicable to the particular commodity are given. If it is not refused it will be absolutely certain that the railroad concerned will recoup itself for the losses it will incur on the particular traffic involved by maintaining an unjustly high rate on other traffic where it does not have to meet water competition. The total cost per ton mile is the figure that should be used, because it takes into consideration, besides fixed charges, freight traffic and all variations of train load, empty car mileage, distribution of cars, repairs, terminal expenses and all the multifarious items that go to make up the cost of operating the railroad which would not be the case if the cost of handling any particular class of traffic only was considered. It is proper from an economical standpoint also, because the cost of handling the unit of weight (ton) per unit of distance (mile) is a measure of the efficiency of any interest engaged in the transportation of commodities.

It has been the failure to apply this, or some similar plan based on the cost of performing the service, that has been the cause of the practical destruction of water traffic, not only on inland waters but the coastwise traffic as well, and it is extremely doubtful if it can ever be revived unless it is protected in some way. If water transportation is more efficient than rail it should be protected from destructive competition, and if not it should be so demonstrated and be allowed to die a natural death and be decently buried; it should not be destroyed because for the time being it happens to be in the power of the railroads to destroy it.

The application of this plan would do no injury to any interest or section. It would not injure the railroads, in which the savings of the public are invested, because they would not be permitted to perform a service for which they received a sum less than cost. It would not injure the purchasers of transportation, because those receiving a service for less than cost have no right to demand that others should pay an excessive rate for its service in order to make up the deficiency. It will not give the water transportation anything to which it is not economically entitled, because if it cannot perform the service at a rate equal to or less than the cost to the railroads it is not as economical and cannot expect to be supported. It furnishes a ready means of regulating and steadying rates, because rail rates could not be advanced beyond a certain point without making water transportation profitable. It would still leave the incentive to both the railroads and the water carriers to increase their economies, in the one case so as to show the lower cost and get the lower rate to meet the water competition, and in the other case to be able to keep their rates low enough to command their share of the trade. It does not violate any law of economics as does any rule that requires a specific differential between the rail and the water rates. The principle, though not so stated specifically, is in practical operation in Germany, where the State-owned railroads will not make any rates at a cost less than the cost of performing the service, and there is the fiercest kind of competition between the water carriers on the free canals and rivers and the State-owned railroads. And it is in Germany where water transportation has reached its highest development and where the most money has been spent in improving inland waterways. This has been accomplished under true economic conditions, as competition is unrestricted except that no service is permitted at less than actual cost, which in the long run is good economics.

In certain cases the railroads are accustomed to use what they call "constructive mileage," which is a device to permit the subdivision of a rate on a mileage basis so as to give some particular portion of the route a larger proportion of the total rate in order to offset some unusual expense, sometimes also because some portion of the route happens to be in a position to dictate it and "get it." In cases of this kind the "constructive mileage" should be used in comparing the through rate with the total cost per ton mile, for the reason that it exists solely because of some unusual expense. An illustration of this "constructive mileage" is the route from Norfolk to Boston via Cape Charles, Va., and New York over the Pennsylvania Railroad and the New York, New Haven & Hartford Railroad. The freight is loaded on cars at Norfolk and ferried across Chesapeake Bay on floats, the distance is about 20 miles, while the "constructive distance" allowed the Pennsylvania Railroad is 100 miles. It is ferried around New York from Jersey City to the Harlem River terminal, which is a distance something less than 10 miles, and the constructive distance allowed the New York, New Haven & Hartford Railroad is 50 miles, making the total "constructive distance" more than 100 greater than the actual distance, because of the extraordinary expense involved in the ferriage and the practical necessity of the maintenance of two terminals where ordinarily one would be sufficient. Like many other devices this can be abused, and if requiring the plan under discussion to be applied to the "constructive distances," where they exceed actual distances, will eliminate the abuses something will be gained for the railroads themselves, especially the weaker lines.

In order to put this plan in operation it is not necessary in

any way to modify the laws already in operation; in fact, it would be better not to modify them. All that is required is a change in the administration of the law, and this is entirely within the control of the Commission. Whether it would be advisable to review the rates already in existence and bring them under the plan outlined is open for argument on both sides. It might be advisable in specific cases to review them on the application of some interested parties, who could show in their preliminary application that they can perform the service by water transportation, at a profit to themselves, at a rate equal to or less than the actual cost to the railroads involved in performing the service, and also that they are ready and have the capital to get into water transportation and compete for the traffic if they are given an equal fighting chance. This would give all the encouragement that can be logically asked for the restoration of water transportation where it has already been destroyed by unprofitable rates to the railroads.

While at the first glance it might be argued that the rule of not allowing any rate to be made at less than the actual cost of performing the service would be a good one to apply to all rates, a closer study of the case will show that this is not true. A railroad handles all classes of freight, commodities from the lowest to the highest classes, and its earnings are the difference between the total amount received for all the transportation and the total cost of performing the service. In a number of instances, as, for instance, the handling of fuel, a rate at less than the cost of performing the service permits the development of the manufacture of some commodity that requires the consumption of fuel into other commodities that will be transported in the higher classes paying the higher rate, so that the earnings of the railroad are increased without increasing the expenses of the service, since the expenses will be the same whether a remunerative rate is charged or not. It is not the same with the waterway, since, by virtue of its lack of speed and its inability to reach all points of delivery, its traffic is limited to what are called the lower classes of freight, of which fuel is an example. Furthermore, the very premise of this argument is based on the protection and encouragement of water transportation.

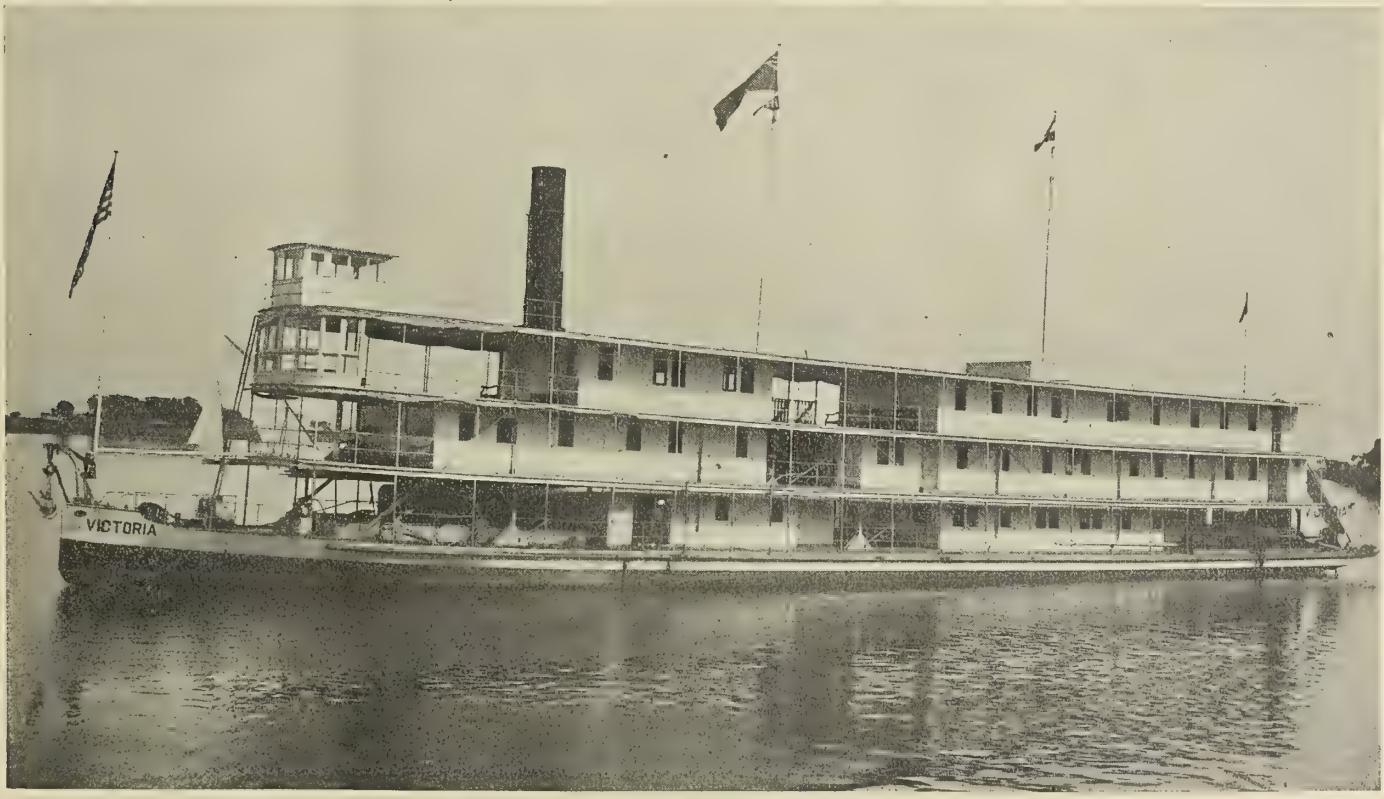
The question as to whether, from an economical point of view, water transportation should be developed at all is a debatable one, and there are plenty of arguments on both sides, but they cannot be included in this article.

English Shallow Draft Boats for Foreign Service

During the last few years a great variety of shallow draft vessels, ranging in size from a 60-foot motor boat to a 260-foot paddle steamer, have been built by Ritchie, Graham & Milne, Whiteinch, Glasgow, for foreign service. One of the largest of these is the stern-wheel steamer *Victoria*, shown in the accompanying illustration, which is 200 feet long, 28 feet beam, with a molded depth of 5 feet 6 inches. The steamer is propelled by 750-horsepower compound-surface condensing engines, and was built for the Anglo-American Steamship Company for tourist service on the River Nile.

Even larger than the *Victoria* is the paddle steamer *Shalimar*, which is used as a railroad ferry across the River Hooghly, India, to connect two railway systems. The hull is 260 feet long, 45 feet beam, with a molded depth of 11 feet, and is equipped with engines aggregating 1,200 horsepower. Three lines of track and six turntables are fitted on the deck for the transportation of the railroad trains.

Other recent productions of shallow draft steamers by this company include the stern-wheel steamer *Congolia*, 75 feet by 14 feet by 3 feet 6 inches, molded, with high-pressure engines of 30 horsepower, built for passenger and cargo service on the Congo River, and the towing steamer *Rio Machado*, 180 feet by 36 feet by 9 feet, molded, with triple-expansion engines of 900 horsepower, giving the vessel a speed of 12 knots, built for passenger and cargo service on the River Amazon in South America.



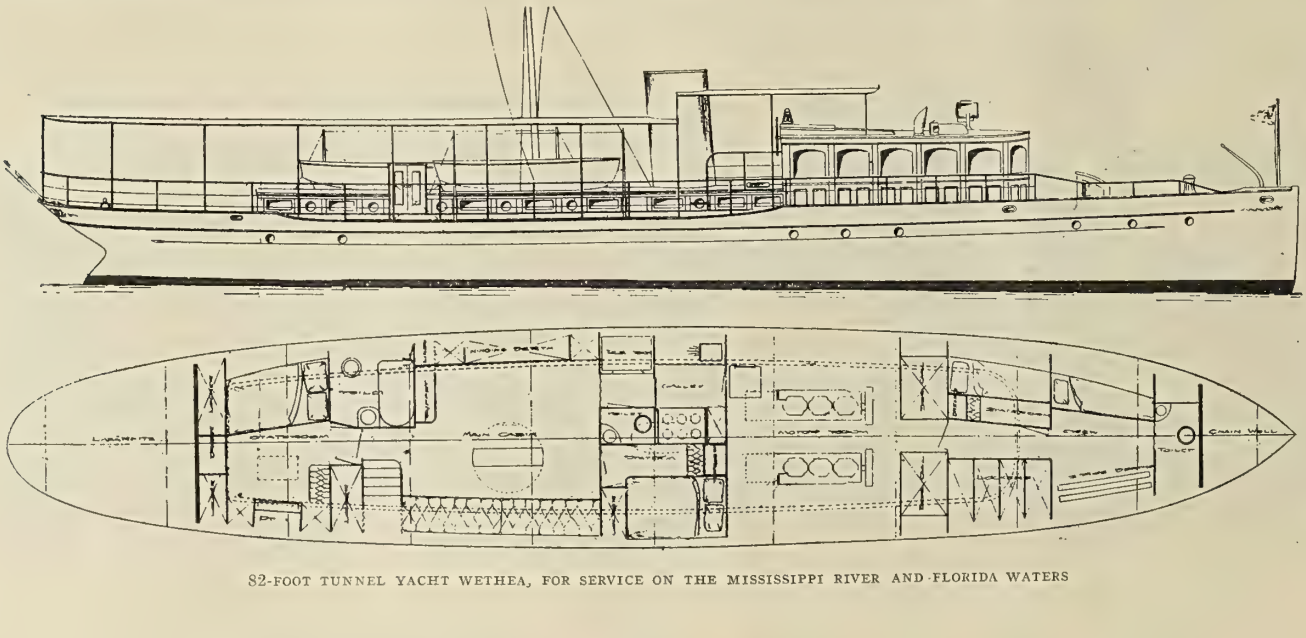
A STERN-WHEEL, ENGLISH-BUILT STEAMER FOR SERVICE ON THE NILE

A Twin Screw Shallow Draft Motor Boat with Tunnel Stern

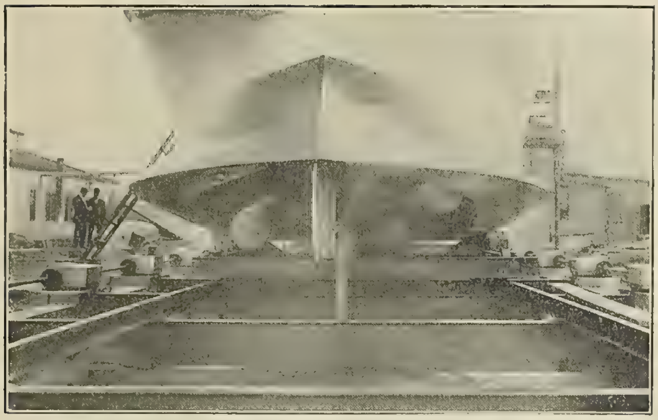
Since the average cruising motor boat is of small size, the necessity of designing a special type of motor boat for shallow draft work has not been apparent to many, but when it is known that in order to navigate some of the most interesting parts of the rivers in Florida it is necessary to have a boat whose draft is less than 30 inches, it is evident that something besides the ordinary ocean-going cruiser must be used. For use in such waters an interesting type of shallow draft motor boat has been built by the Matthews Boat Company, Port Clinton, Ohio, for Mr. H. W. Baker, St. Paul, Minn. The boat, named the *Wethea,* is a twin-screw 82-foot tunnel stern yacht which, with a displacement of 90,000 pounds, draws only 28 inches of water, and makes a speed of 14 miles an hour with two 60-horsepower heavy duty engines. The *Wethea* is not only a wide departure from the ordinary type of cruising yacht on account of its limited draft, but it is so designed as to be capable of navigating not only shallow bays and rivers, but also the open, unprotected waters where heavy seas are encountered.

THE WETHEA AT FULL SPEED

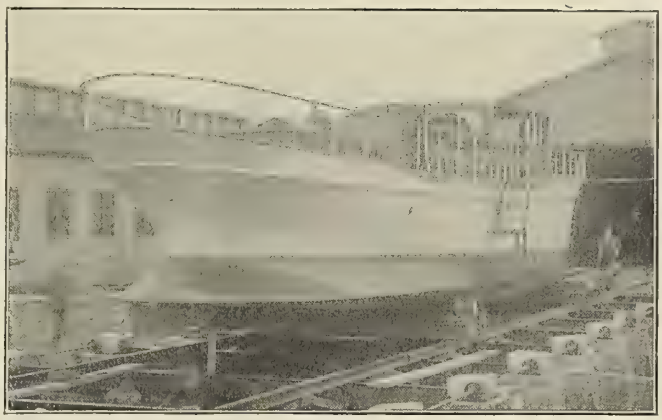
The unusual feature of this boat is the tunnel stern, which not only reduces the draft to the desired limit, but also forms a thorough protection for the propellers. Ordinarily a large amount of floating débris is found in shallow water, and there is a tendency for the propellers to become entangled by sucking the floating material under the stern, but in the *Wethea* the propellers are entirely housed by the tunnel shape of the stern, which, owing to the construction of the chime piece, extends well under the waterline.



82-FOOT TUNNEL YACHT WETHEA, FOR SERVICE ON THE MISSISSIPPI RIVER AND FLORIDA WATERS



VIEW OF TUNNEL STERN

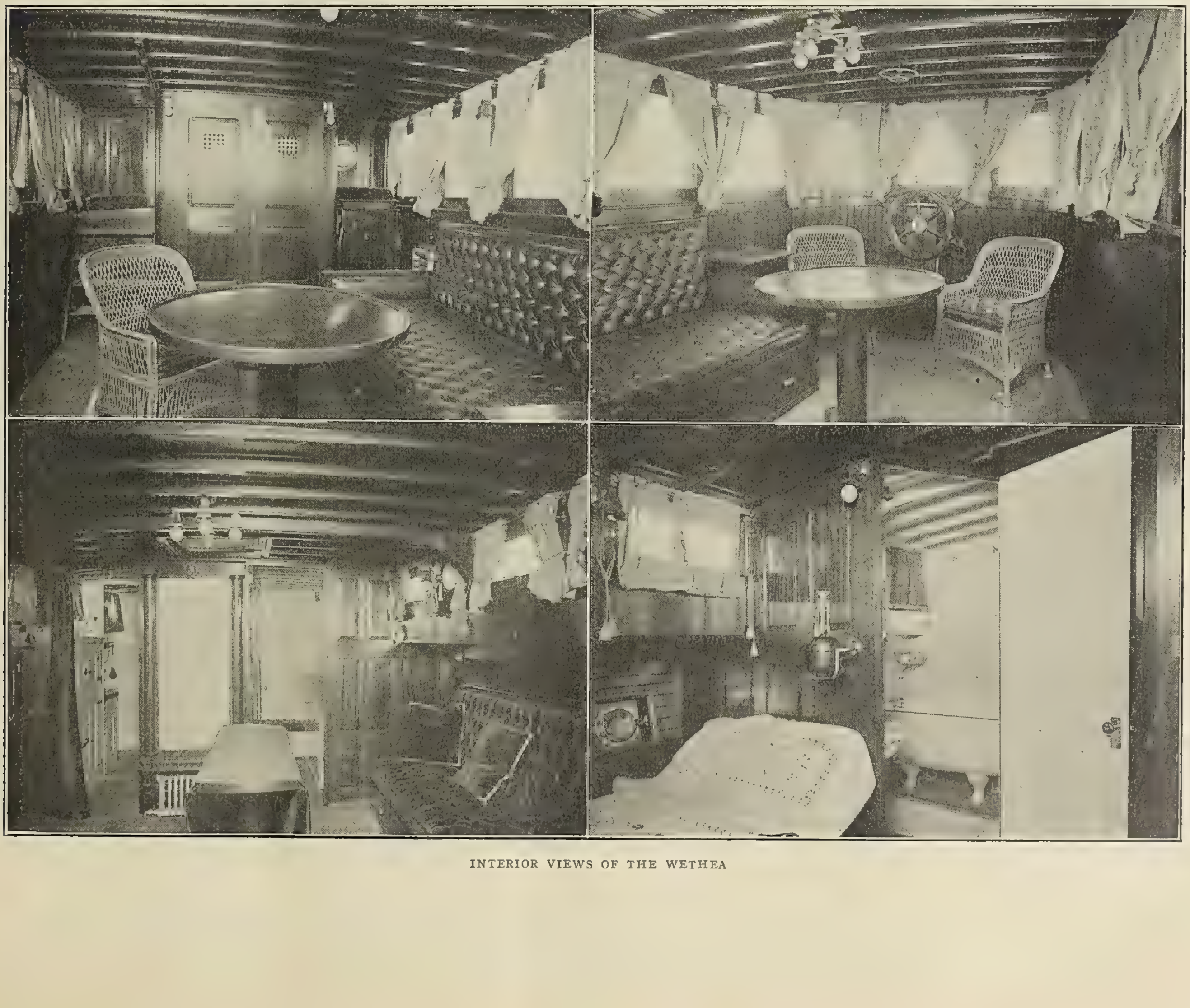


UNDER-WATER BODY

The hull, which is 82 feet long and 14 feet wide, is divided by two steel watertight bulkheads and two wooden watertight bulkheads located at the ends of the boat. The planking is of long leaf yellow pine below the waterline and white Virginia cedar above the waterline. The decks are of double thickness calked pine and all the houses are finished in African mahogany throughout.

The crew's quarters, captain's room, storeroom, etc., are located forward of the engine room, which is separated from the other parts of the boat by the steel bulkheads already mentioned. Aft of the engine room the rest of the boat is taken up with the owner's and guests' quarters, together with the living room. Immediately aft of the engine room is the galley, fitted with a large refrigerator, coal range, provision lockers, etc. Aft of the galley are the guests' accommodations, finished in light blue and gold trimming. Immediately aft of the guests' accommodation is the general cabin or dining saloon, with a companionway to the deck. This cabin is fitted for the use of chairs and a divan seat, the total length of the room being about 13½ feet. On the port side is a folding panel berth, which gives room for three sleeping berths in this compartment. The after part of the boat is given up entirely to the owner's quarters, which are elaborately furnished, as shown in the illustration.

The engine room contains two 60-horsepower, 6½-inch by 8-inch Sterling heavy duty gasolene (petrol) engines, together with gasolene (petrol) tanks of 600 gallons capacity. There is a Fay & Bowen independent electric light 4-kilowatt plant which furnishes current for lighting and operating fans and other accessories. The boat is heated throughout by hot water with radiators in each room.



INTERIOR VIEWS OF THE WETHEA

Launch of Collier Middlesex

The New York Shipbuilding Company, Camden, N. J., launched the steel collier *Middlesex* Sept. 21, for the Coastwise Transportation Company, Boston, Mass. The ship is of the following dimensions:

Length between perpendiculars.....	377 feet 4 inches.
Beam, molded	50 feet.
Depth, molded	33 feet.
Draft, loaded	25 feet.
Cargo carried at this draft.........	7,250 tons.
Gross tonnage	4,730 tons.
Speed at sea, loaded...............	10 knots.

The vessel has a single deck of steel, with poop 80 feet, bridge 17 feet, and forecastle 34 feet long with seven steel watertight bulkheads, two pole masts, straight stem and semi-elliptical stern. A deep double bottom is fitted all fore and aft for the carriage of water ballast, and particular attention has been paid to the construction of this part of the vessel; the plating being of extra strength and fitted flush; no wood ceiling is fitted.

The five cargo holds are entirely clear of beams and pillars, the deck being supported by deep arched beams and web-frames placed midway between the watertight bulkheads; a continuous trunk, 24 inches deep by 30 feet wide, is carried on the upper deck for the full length of the cargo spaces. Large steel cargo hatches are in the top of this trunk, eleven in all. Six steam winches are fitted in connection with five pairs of king posts for raising the hatch covers and securing them in place when open.

The accommodations consist of a 'midship deck-house on the bridge deck for the captain's stateroom and spare room, with a pilot-house over. The saloon officers' and petty officers' berths, pantry, toilet, etc., are in the bridge; the engineers, cooks, steward, messrooms, refrigerator, toilets, galley, etc., are in the houses on the poop deck, and the oilers, seamen and firemen are berthed in the poop abreast the engine casing.

The steam windlass is fitted with warping ends and located on the forecastle deck, with the engine below in forecastle. The steam capstan is on the after end of the poop deck, with the engine below. The steam steering gear is on the upper deck abaft the engine casing, with connection to the steering stations in pilot-house and on the navigating bridge; auxiliary hand-steering wheels are also provided.

The propelling machinery is placed aft, and consists of one triple-expansion, inverted reciprocating engine of about 3,100 indicated horsepower and two single-ended Scotch boilers, having a working pressure of 175 pounds.

The vessel is intended for the coastwise coal-carrying trade between Baltimore and Boston. Loading and discharging gear is not fitted on board, the two terminal points being arranged with these facilities.

American River Boats for Foreign Service

During the last year the steamboat builders on the Western rivers of the United States have had very little business for American owners outside of government work, but the shipyards have been fairly busy with foreign contracts. James Rees & Sons Company, Pittsburg, Pa., which is one of the pioneer river steamboat builders, has turned out during the last year fourteen sternwheel river boats for the Companhia Navegacao do Amazonas of Brazil in fulfilment of a contract made in Paris the latter part of July, 1911. These boats have been shipped to Brazil in knock-down form and eight of the boats have already been launched at Para. One of these went into service on the Amazon early in August, leaving the port of Para for a three-months' voyage up the Amazon and one of the tributaries with a commission on board sent out to examine and report on the conditions and future prospects of the valley. This boat carried 90 tons of fuel and freight, besides passengers, baggage, etc., on 2 feet 8 inches draft forward and 2 feet 3 inches draft aft. The consumption of fuel for twenty-four hours was estimated at 5 tons of dirt coal and her steering qualities met with ready approval.

AMERICAN RIVER-BOAT PRACTICE CARRIED OUT ON THE NILE BY THE TOWBOAT EGYPT

Another successful boat built by this company for service on the Magdalena River in the Republic of Colombia, South America, was the *Perez Rosa,* a boat 170 feet long, 33 feet beam, 5 feet depth of hold with a capacity for 500 tons. This boat was described in some detail in the November, 1911, issue of International Marine Engineering. Since going into service she has made several very successful trips.

Included in the work now on hand in the yards of James Rees & Sons Company are two steamboats 75 feet by 18 feet by 3 feet for the Madeira and Mamore Railway Company of Bolivia, and one light-draft river gunboat and ram, the hull of which is nearly completed. They also have six barges under construction for Bolivia.

Another interesting boat built by this firm for foreign service is the river towboat *Egypt,* which has been in service on the river Nile for some time. The methods of towing on the Nile heretofore were quite different from the methods used on the Western rivers of the United States, but since the *Egypt* was put into service, aided by the instructions supplied by the builders, the pilot of the boat, who was a native who had never been on a sternwheel boat before, rapidly picked up the principles of towing with a sternwheel steamer, and the vessel now handles a tow of 900 tons up the river on a fuel consumption of 800 pounds of coal per hour, making regular trips of 1,600 miles a month.

Shallow Draft Motor Boats for Commercial Purposes

The remarkable development of motor boating as a sport has been followed by a no less remarkable development of the motor boat for commercial purposes. Although this phase of motor boating has not attracted so much attention as has the use of the racing craft or the cruiser, nevertheless the adaptation of the motor boat to commercial purposes has rapidly increased, especially in shallow waters such as harbors, bays, rivers and their tributaries, where the demand for a small, inexpensive boat makes the motor boat a formidable competitor to the large steamboat on which river traffic formerly depended. It is impossible to lay down the details of any representative type of commercial motor boat, as the design depends upon local circumstances and the kind of traffic which must be handled, but from the great number of different types that are in use a few representative examples may be selected.

FIG. 1.—MOTOR TUG NEMADJI

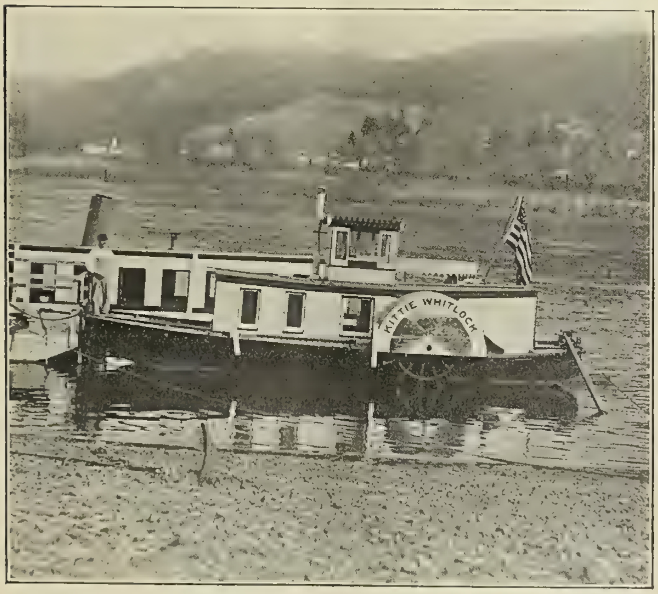


FIG. 2.—A SIDE WHEELER DRIVEN BY A 15-HORSEPOWER BUFFALO ENGINE

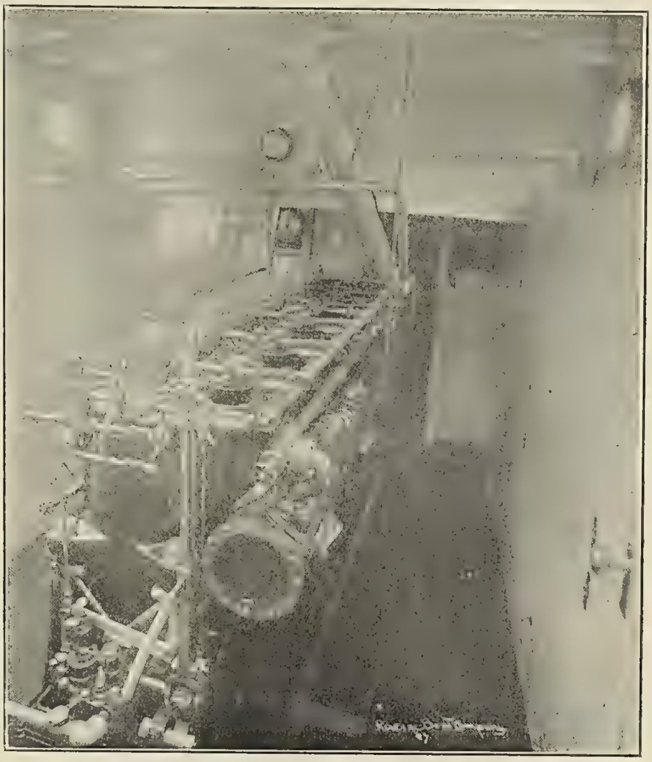


FIG. 3.—ENGINE ROOM OF THE NEMADJI

FIG. 4.—LAKE GEORGE MOTOR BOAT MOUNTAINEER

Out on the Great Lakes the Racine Boat Company, of Racine, Wis., has recently delivered to the United States Engineers at Duluth, Minn., a thoroughly up-to-date motor tug which is proving a valuable adjunct to the engineering department. The boat is 60 feet 9 inches long over all, 55 feet 10 inches long on the waterline, with a beam of 12 feet and a draft of 4 feet. The tug is of heavy construction throughout, the keel being a clear, well-seasoned white oak, sided 6 inches and tapered to 4 inches at the after end. The center keelson is one length of long-leaf yellow pine sided 6 inches and molded to a depth of 4 inches; the side keelsons are of yellow pine sided 3 inches and molded 2½ inches. The frames are of white oak, sided 2 inches and molded 2 inches at the hood and 3 inches at the heel, spaced 12 inches. Bulkhead stringers of yellow pine, sided 3 inches and molded 2½ inches and tapered to 3 inches by 2 inches, are fitted, as also are side stringers of yellow pine, 3 inches by 2½ inches tapered to 3 inches by 2 inches. The stern post is of oak, sided 2 inches, and the stem of white oak, sided 6 inches and molded to a depth of 18 inches. The garboard strakes of planking are of white oak 2 inches thick, the next two planks being 1⅞ inches thick. The rest of the planking is 1¾ inches thick.

The motive power consists of a 125-150 horsepower air starting and reversing Standard engine, built by the Standard Motor Construction Company, Jersey City, N. J., which gave the *Nemadji*, as the boat is called, a speed of 12.38 miles an hour on a trial run from Racine to Milwaukee and return.

In the engine room is also installed an electric generator of 15 volts, 15 amperes capacity with storage batteries of 13 volts, 120 amperes capacity, and a switchboard for lights. Electric lighting is used throughout the boat and a hot water heating system is installed.

Company, Jersey City, N. J. The engine drives a propeller 40 inches diameter and 50 inches pitch. There is a shaft tunnel aft to admit this wheel. The motor is located amidships, where a gangway crosses the boat just abaft the motor, with steps leading aft to an after cabin and forward on the starboard side past the motor to the forward cabin. A Standard auxiliary generating set is also located in the engine room.

Motor tunnel boats are also frequently used for light draft canal work and harbor construction. A typical boat of this

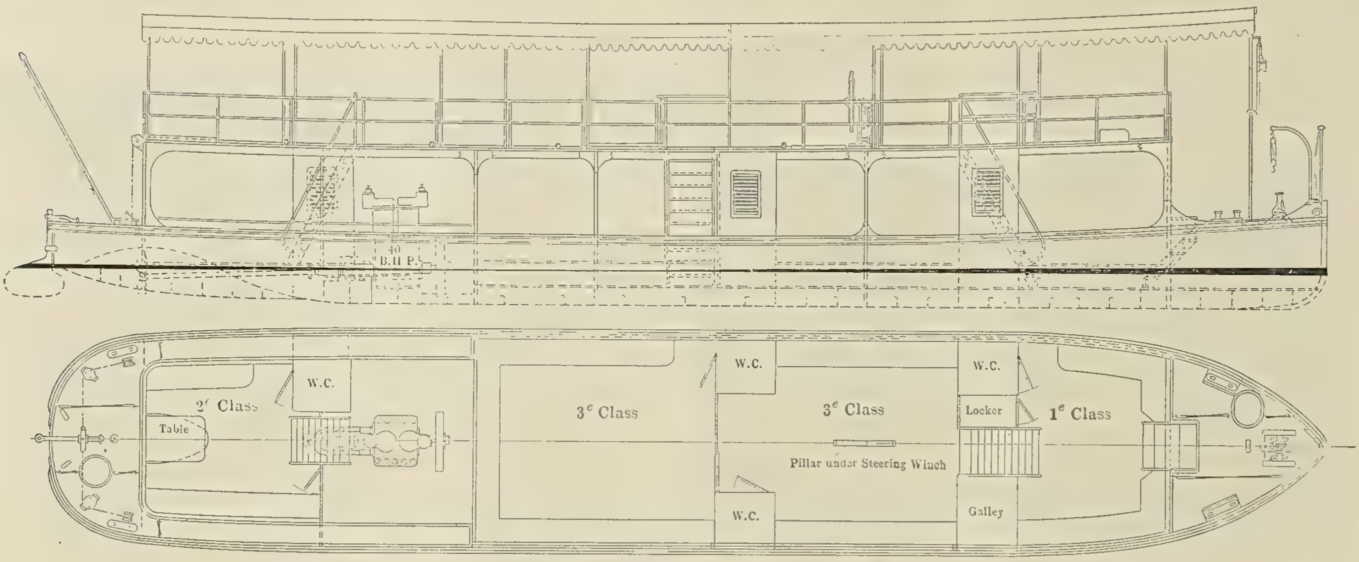


FIG. 5.—MOTOR TUNNEL BOAT BUILT BY MESSRS. KROMHOUT IN HOLLAND

In the extreme fore peak is the chain locker; aft of this are the crew's quarters and sleeping accommodations for four persons; aft of the crew's quarters comes the engine room and aft of that the galley where the hot water heating system is installed. Aft of the galley is the officer's saloon, making a very comfortable and conveniently equipped motor boat for a tug.

Another type of motor boat which is used in competition with steamboats is the *Mountaineer*, which is a passenger boat 70 feet 10 inches long over all, 12 feet 6 inches beam, and 3 feet 6 inches draft with a full load of sixty passangers. This

kind for passenger service not only in shoal protected waters, but also suitable for heavy sea work, has been constructed by Messrs. Kromhout Works at Amsterdam, Holland. We are indebted to Mr. F. W. Uittenbogaart for the following particulars of a typical boat of this class:

The principal dimensions are: Length over all, 70 feet; beam, molded, 11 feet 8 inches; depth of side, 3 feet 8 inches. The draft when loaded with 150 passengers is only 22 inches, while her designed speed is 8 miles per hour. The vessel was built for service in the Far East and shipped there in knockdown form, after being erected and taken adrift in the build-

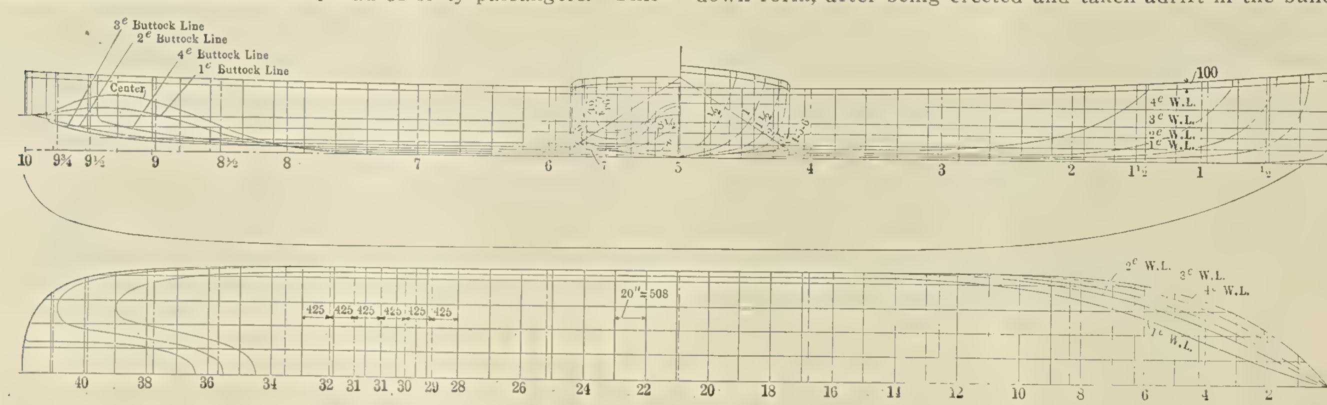


FIG. 6.—LINES OF HOLLAND MOTOR TUNNEL BOAT

boat is owned and operated by the Lake Champlain Transportation Company on Lake George and is used as a sight-seeing craft. She was designed by J. W. Millard & Brothers of New York, naval architects of the large Hudson River day boats. She was built by Alexander McDonald of Mariner's Harbor, Staten Island, N. Y. For motive power the boat is fitted with a 125-150 horsepower 6-cylinder air-starting and reversing Standard engine, built by the Standard Motor Construction

er's yards. As shown in Fig. 5, the vessel has two decks and an awning covers the entire length of the vessel. She is divided into six compartments. The forepeak is used for a chain locker and also contains a galvanized iron water tank. It is separated by a watertight bulkhead from the space reserved for first-class passengers. A small galley is fitted in this part of the boat. Immediately aft of the first class compartment is a space devoted to third class passengers, being

divided by a bulkhead into two sections, one for women and one for men. Immediately aft of this space is the engine room. Aft of the motor room is a space reserved for second class passengers. The hull is built of steel throughout and is necessarily of very light construction. The shell plating, which is of galvanized steel throughout, is of only ⅛-inch thickness. The weight of the whole vessel, exclusive of the propelling machinery, amounts to 12.4 tons.

FIG. 7.—TUNNEL LAUNCH IRENE, BUILT BY MAC LAREN BROS. FOR SOUTH AFRICAN SERVICE

As can be seen from the lines (Fig. 6) there is a tunnel which extends from the stern to over half the ship's length. The metacentric height is 24 inches when the vessel is loaded with eighty passengers on the upper deck and seventy in the spaces below.

The propelling machinery consists of a two-cylinder, four-cycle Kromhout kerosene (paraffin) oil engine of 40 brake horsepower with cylinders 9.06 inches diameter by 11.81 inches stroke. The fuel used is ordinary kerosene (paraffin), which can be obtained practically everywhere. The oil is fed to the motor by an automatic pump controlled by the governor of the engine. Magneto ignition is used. The fuel consumption of this motor in actual service is about 16 pints of oil per hour.

Another typical tunnel motor boat for shallow draft service is the 35-foot launch shown in Fig. 7, which was built by MacLaren Brothers, Ltd., Sandpoint Shipyard, Dumbarton, for service in South Africa. She is fitted with a 30-horsepower motor and has a guaranteed speed of 10 knots. Owing to the special type of shallow draft tunnel stern, this launch when loaded with her complement of passengers does not draw more than 14 inches of water. She is used by the owner for commercial purposes, as the shallow rivers are the only means of communication in that part of the country.

For trading purposes in the central of Africa, the Seamless Steel Boat Company, Ltd., Wakefield, has built and shipped in knock-down form a motor barge 80 feet long, 15 feet beam and 5 feet depth of hold, fitted with a 40 brake horsepower heavy oil motor, which gives the barge a speed of from 6½ to 7 miles per hour when carrying 80 tons of cargo on a draft of 3 feet 9 inches. The design of the barge

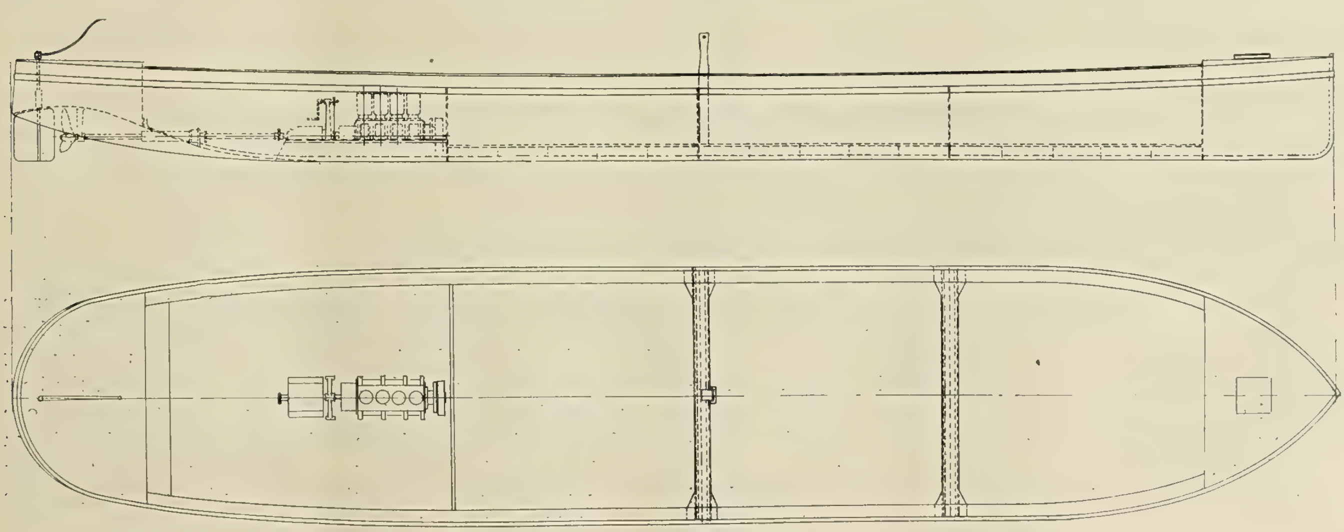


FIG. 8.—SEAMLESS STEEL MOTOR BARGE, 80 FEET BY 15 FEET BY 5 FEET

is similar to several other types of seamless steel shallow draft launches built by this company.

Messrs. John I. Thornycroft & Co., Ltd., of Woolston Works, Southampton, has built to the order of the British & American Tobacco Company a unique twin-screw motor launch called the *Rosette,* which is intended for river service at Hong Kong, carrying samples of goods. The little vessel was required to have a fair turn of speed, 9 knots being guaranteed, and the draft when loaded with 2 tons was not to exceed 1 foot 3 inches on account of the shallowness of the river. Living quarters were to be arranged for the crew and officers and also a certain amount of bulky cargo had to be carried.

On trial the *Rosette* fulfilled all that was required of her, a speed of nearly 9¾ knots being obtained on 1 foot 3 inches draft when loaded with 2 tons. The general arrangement is as follows: A short deck is arranged forward for working anchors, warps, etc., with a saloon for four people fitted with

FIG. 9.—THE ROSETTE IN RIVER SERVICE AT HONG KONG

berths, etc. Opening off the saloons are galley and pantry and toilet. Amidships is fitted the cargo hold, divided into two spaces and fitted with sliding doors. The motor space is located abaft the cargo space and abaft that again is a space for the crew. The house over the accommodation is carried right out to the ship's side, and to provide a passage fore and aft a battened platform is built out at the sides, supported off the ship's side by means of tube stays. A bridge deck is arranged over

FIG. 10.—PRODUCER GAS BOAT ST. LUCIE

the forward accommodation and is provided with canvas awning and curtains.

The propelling machinery consists of two sets of Thornycroft M-4 type of motor using kerosene (paraffin) as fuel. The engine is designed specially for marine work and fitted with standard vaporizer. The motors drive solid propellers of Thornycroft bronze through standard combined clutch and reversing gear.

Internal combustion engines for commercial motor boats are not limited to the use of gasolene (petrol) for fuel, since certain types of engines are built which can be adapted to the use of various grades of oil, including kerosene (paraffin), distillates, coal oil, alcohol, and during recent years some of them have been showing great economy through the use of producer gas. The Wolverine engines, manufactured by the Wolverine Motor Works, Bridgeport, Conn., have been used in many kinds of work, such as towing, freighting, dredging, fishing and for passenger service in all parts of the United States, as well as in the bays and rivers of many foreign countries, such as South America, Africa, Belgium, Holland, France, etc. Some 75-horsepower engines of this type have recently been installed on river boats in Florida in connection with suction producer gas plants, with excellent results as to operation, but the most interesting feature regarding this fuel

FIG. 11.—THE SELKIRK

is the great saving in running expenses; as, for example, in one instance a 75-horsepower engine operating on gasolene (petrol) required a bill of $65 (£13.3) a trip for fuel, as against $10 (£2.3) spent for coal on the same run—a saving of $55 (£11.3), or about 85 percent on each run. Since this boat made two runs a week, this meant a saving of $110 (£22.6) a week to its owners on account of the change from gasolene (petrol) to producer gas. Instances of this sort certainly furnish food for thought for anyone owning or contemplating the ownership of a marine gas engine for work or pleasure.

Fig. 10 shows a light draft freight boat, the *St. Lucie,* 114 feet 6 inches long over all, 23 feet 2 inches beam, and 3 feet draft, equipped with a 75-horsepower producer plant capable of giving the boat a speed of 8 miles per hour. This boat is said to be the first stern wheeler in the world fitted with a producer gas plant, and since she has been in use on the St. John's River in Florida she has scored a victory in both speed and reliability over the older steamboats on that river.

Another interesting boat equipped with a smaller Wolverine engine is the *Selkirk,* shown in Fig. 11, which is 68 feet long by 11 feet beam, fitted with a 27-horsepower motor using gasolene (petrol) as fuel. In the photograph shown, the boat is towing in the usual Western river manner two scows, one 50 feet long by 16 feet beam and the other 62 feet long by 14 feet beam, each drawing 3 feet of water. This tow was driven upstream against a three-mile-an-hour current at the rate of fifty miles a day.

An English Type of Shallow Draft Towboat

Fig. 1 shows a type of single-screw towing launch of 4 feet draft for river and sea work combined, which is manufactured by Edward Hayes, Watling Works, Stony, Stratford. The boat is 51 feet long over all, and 11 feet wide, with 6 feet

FIG. 1

FIG. 2

2 inches depth to the deck at the side amidships. The engine is of the standard Hayes type, built especially to meet the requirements of such a craft, having cylinders 8 inches and 16 inches diameter by 10 inches stroke. There is a large condenser and brass-lined air and circulating pumps of large capacity, together with feed and bilge pumps, the latter having interchangeable valves. A special three-bladed propeller of high towing efficiency, running at 260 revolutions per minute, is used. Steam is supplied by a marine return-tube boiler, built for 120 pounds working pressure. Roomy cabins, well ventilated and fitted out with all conveniences, are arranged forward and aft under the deck. For tropical work an awning is placed overhead on a galvanized frame with suitable gangways. The speed of this type of boat on trial is usually a little over 12 miles per hour, this varying slightly with weather conditions at the time of the trial.

Fig. 2 shows another standard type built at the same works for a draft of 3 feet, where good towing power is required. The boat is 60 feet long, 11 feet wide, and is propelled by twin screws driven by separate compound engines, having cylinders 6 inches and 12 inches diameter by 8 inches stroke, running at about 350 revolutions per minute, both exhausting into separate condensers of the vertical type, built very low and placed in the center of the boat just aft of the engines. This condensing plant was designed by the builders especially for shallow draft work, and it is so located that the deck comes over it, thus giving considerable extra deck space for stowing bulky cargo which otherwise would not be secured. The pumps on this boat are driven by a small compound surface condensing engine, having cylinders 3½ inches by 7 inches diameter by 5 inches stroke. The usual type of marine return-tube boiler is used for furnishing steam, and the speed of this type of boat is usually about 11 miles per hour.

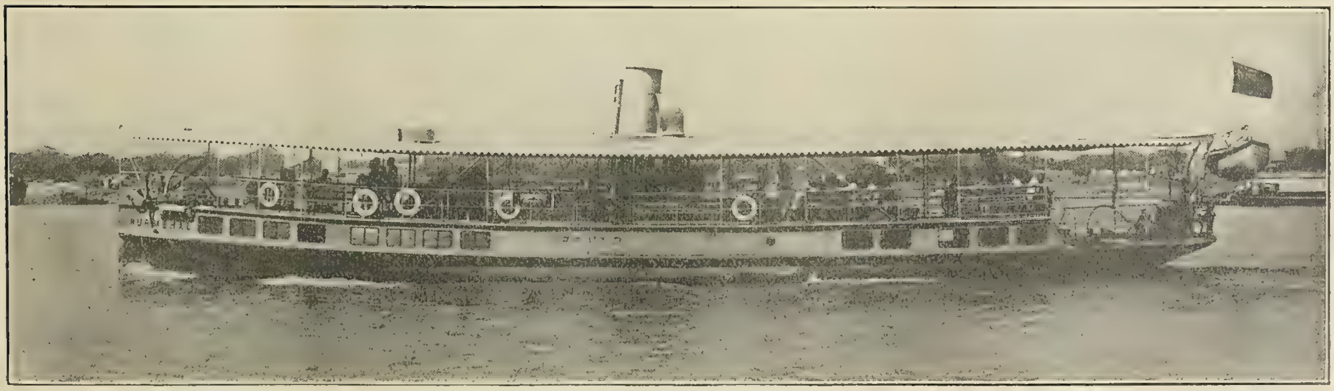
Shallow Draft Ferry Steamers

For shipment in knock-down form to India, Messrs. John I. Thornycroft & Company, Ltd., of Southampton, are building two interesting shallow draft ferry steamers for service at Calcutta. The principal dimensions of the vessels are as follows:

Length between perpendiculars.....	100 feet.
Breadth	24 feet.
Depth	7 feet 6 inches.
Draft, maximum	3 feet 2 inches.
Speed	10 knots.

The vessels are arranged to carry in all about 200 passengers, seating accommodation having been arranged for 100 of these. The passenger space is divided into two classes, the first class being situated forward on the upper deck in front of the boiler casing, and separated by portable barriers from the remainder of the space, which is set apart for second class passengers.

On the upper deck there are four wide gangways on either side, giving ample room for embarking large numbers of passengers quickly. Two of these gangways are arranged for first class passengers and the other two for the second class. The upper deck has a fine area, and will be capable of ac-



ONE OF THE CALCUTTA FERRY STEAMERS

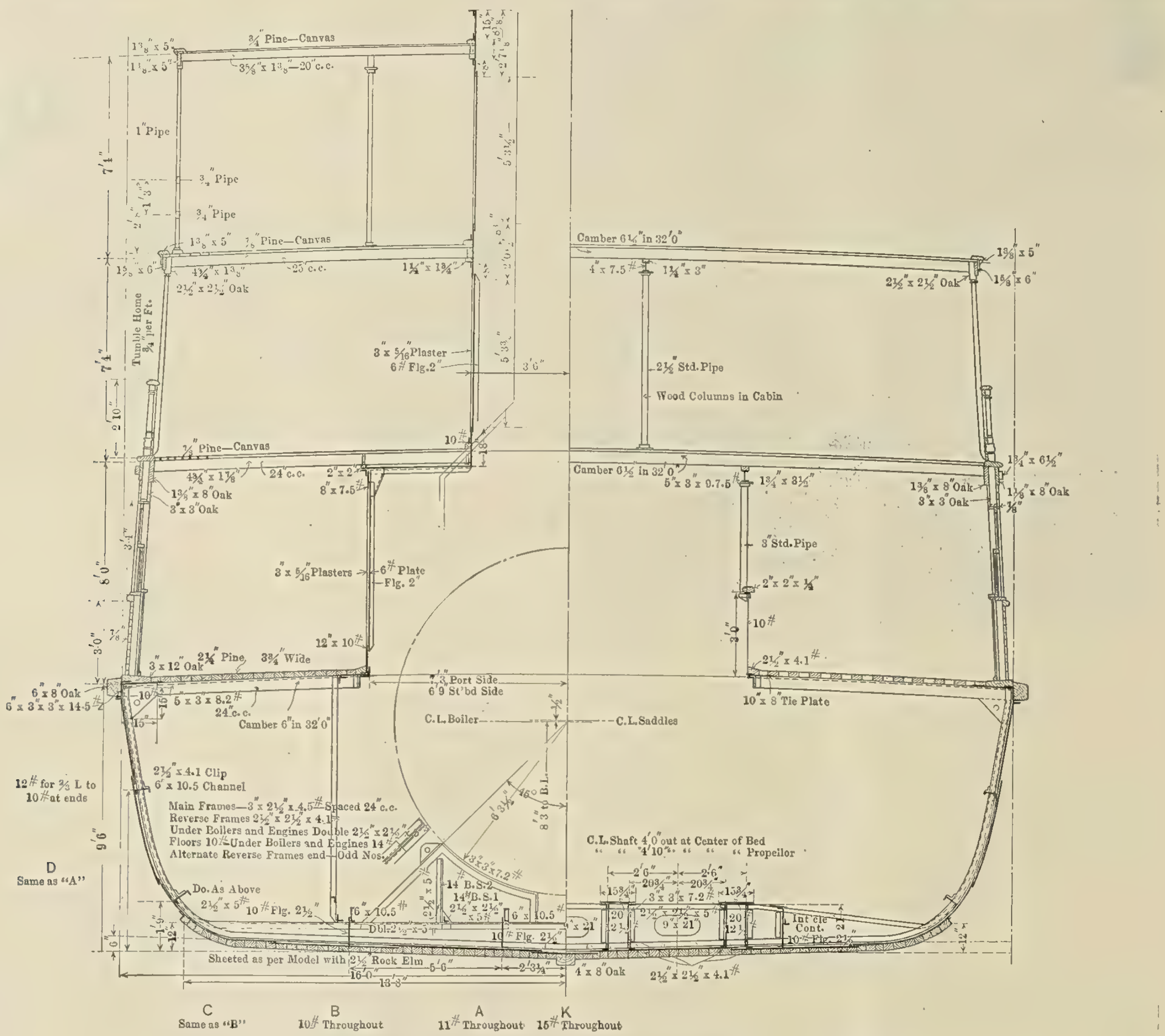
commodating a large number of passengers with comfort. A light wood awning covers this deck.

The machinery will consist of two sets of vertical, triple-expansion condensing engines, supplied with steam from one cylindrical boiler working under forced draft on the closed stokehold principle.

These vessels are generally similar to eleven others built within the past few years by Messrs. Thornycroft for the same authority, but are of somewhat shallower draft and less speed. In the present case, as previously, the boats will be shipped in pieces and re-erected at Calcutta, where they will be placed in service.

Shallow Draft, Tunnel Stern Steamer Thousand Islander

The steamer *Thousand Islander* was built in the spring of 1912, and delivered in July of the same year by the Toledo Shipbuilding Company, of Toledo, Ohio, for the Thousand Island Steamboat Company, of Clayton, N. Y. The principal dimensions of the vessel are:



MIDSHIP SECTION OF THE THOUSAND ISLANDER

Length over all	172 feet 9 inches.
Beam, molded	32 feet.
Depth, molded	9 feet 6 inches.
Gross tonnage	355
Net tonnage	241

The ship is of the tunnel stern, shallow draft, twin-screw type, and is built with main, promenade and boat decks. There is life-saving equipment enough for 1,000 passengers, included in which are three 18-foot lifeboats and one 14-foot working boat. All decks, cabins, etc., above the main deck are constructed of wood, while that part below the main deck is of steel.

General Arrangement

The hold is arranged for the chain locker, crew's quarters and power plant. From frame No. 1 to No. 16 there are accommodations for four firemen and seven deck hands. There are stateroms enough from frame No. 16 to No. 26 to care for the souvenir boys, mess boy, bartender, chef and assistant, two waiters, an oiler, the watchman and steward. The two boilers and engine, together with the auxiliaries, take up the space from frame No. 26 to No. 55. The space from frame No. 55 to No. 66 is occupied by fourteen people, including the chief engineer, assistant engineer and electrician. All berths are of metal, while the quarters are finished in redwood.

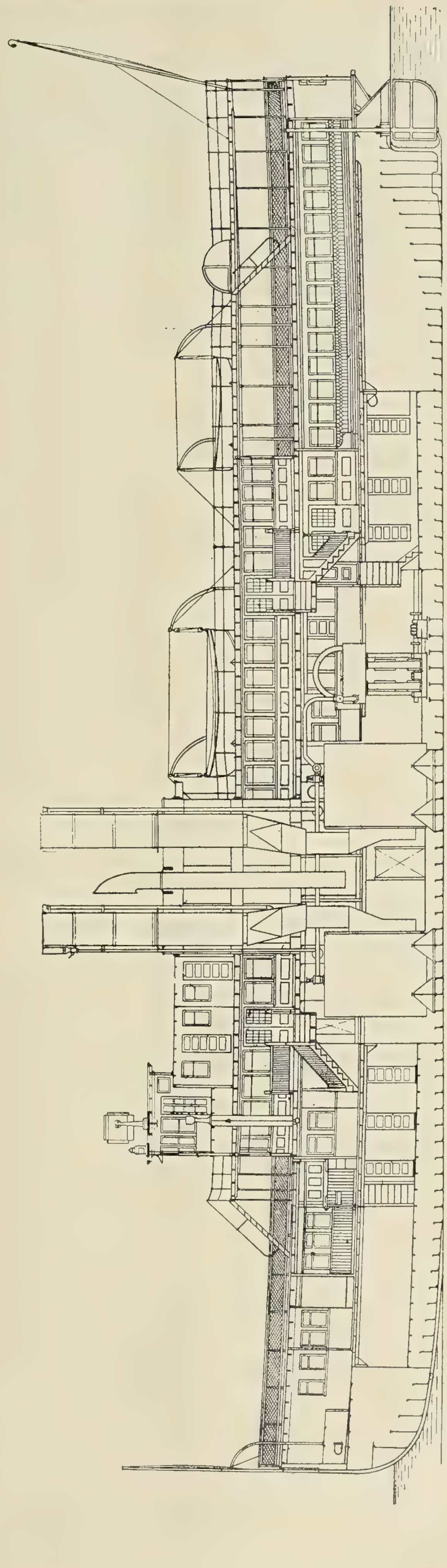
On the main deck a hand-capstan windlass occupies the space as far aft as frame No. 7. From frame No. 7 to No. 12

space is taken up by the men's toilet, which is finished in redwood. The bar-room is finished in chestnut, and leads as far aft as frame No. 19. Access to the toilet and bar-room is maintained by a 3-foot passage extending along the port side of the ship forward from frame No. 19 and terminating in the windlass room. This passage is finished in oak. The deck from frame No. 19 to No. 43 is clear, with the exception of the boiler casing, which is 14 feet wide and extends from frame No. 26 aft to No. 44. The upper part of the boiler casing forward is cut away to make room for the stairs leading from the promenade to the main deck. The forward gangways extend on each side of the ship from frame No. 22 to No. 25. This part of the ship is finished in oak. The ship is coaled through five 20-inch diameter scuttles placed between frames No. 26 to No. 42. The starboard side of the ship from frame No. 43 to No. 54 is taken up by the galley, which extends from the ship's side to the engine-hatch coaming. A passage is left between the galley and boiler casing to connect with an athwartship passage between the forward engine-hatch coaming and the after boiler casing, making a clear passage from port to starboard of 42 inches wide. This passage, in turn, connects with a fore and aft passage on the port side leading from the main deck amidships to the social hall aft. The ladies' lavatory on the port side, extending from frame No. 43 to No. 56, communicates with this passage. The engine hatch is 13 feet wide and extends from frame No. 46 aft to No. 54. The social hall, extending from frame No. 54 to No. 62, includes the stairs leading from the main to the promenade deck, while gangways take up the space from frame No. 56 to No. 59. The breakfast room, extending from frame No. 62 aft to the stern, includes the linen room on the starboard side and the purser's room on the port. The breakfast room is finished in quartered oak, and contains twenty tables with redwood tops. The purser's room, linen room, galley and ladies' lavatory are finished in redwood, while the social hall is finished in mahogany.

The promenade deck extends from stern to stern, and is clear but for a closed cabin 19 feet wide which extends from frame No. 19 to No. 62. The forward end of this cabin contains the stairs leading to the main deck, while a stack casing, 7 feet 6 inches wide, extends from frame No. 31 to No. 41. The after end of the cabin is taken up by stairs leading to the social hall on the main deck and by a souvenir counter placed in the extreme end. The deck is supported amidships by the boiler casing, which in turn is given additional strength.

Forward and aft of the boiler casing I-beam stringers in connection with gas-pipe stanchions are used in giving support to the deck, while the space between the promenade and main deck is built up of wood. The deck itself is of ⅞-inch pine covered with canvas, and supported by 4¾-inch by 1⅞-inch pine beams spaced 24 inches center to center. The deck is enclosed by a railing, consisting of an oak rail 1¾ inches by 5 inches, supported at equal intervals by oak stanchions, the whole being enclosed by galvanized wire iron work. Window stools and the sash of cabin windows are of mahogany, while the cabin exterior is finished in redwood and the interior is finished in white pine covered with white enamel. The souvenir stand is of mahogany, together with the newel posts of stairways and the wood finish around the pipe stanchions.

The boat deck extends from frame No. 17 aft to the extreme stern. The deck forward carries the usual pilot house and chart room, together with accommodations for the captain, owner, maid and mate. The stack casing, 7 feet 6 inches wide, extends from frame No. 31 to No. 41. Aft of frame No. 42 there are four lifeboats. The stairs leading to the promenade deck are located between frame No. 72 and No. 75. The entire deck is enclosed by a ¾-inch pipe railing about 2 feet 9 inches above the deck, supported by ¾-inch pipe

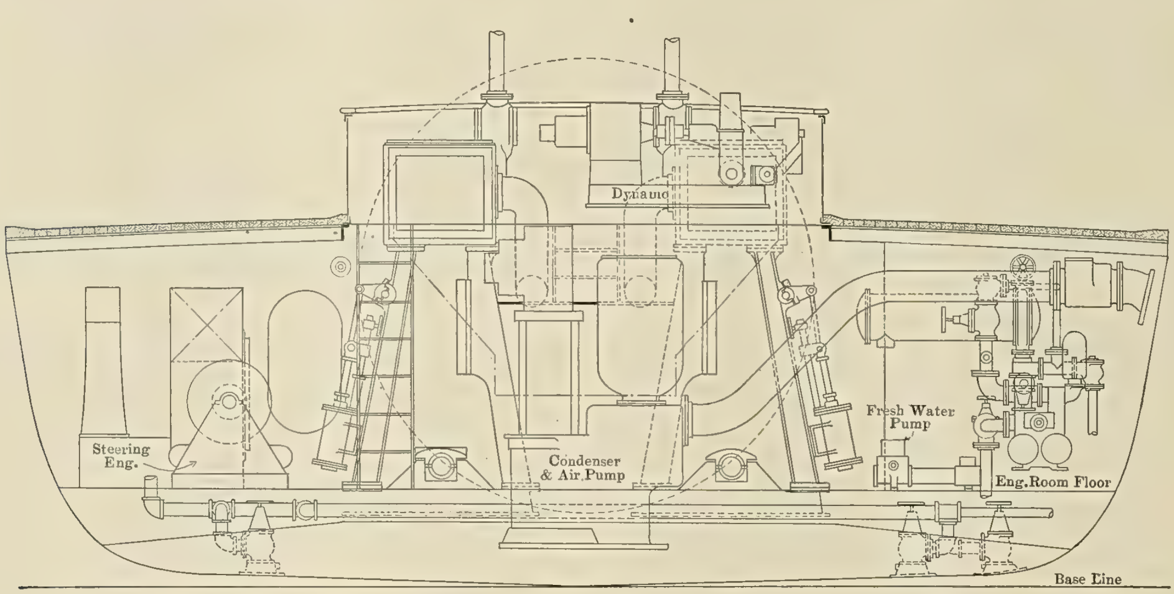


INBOARD PROFILE OF THOUSAND ISLANDER

stanchions placed at 5-foot intervals. The support for the deck is arranged for in the same manner as the promenade deck. The deck is of ⅞-inch pine covered with canvas. The beams are of pine, 1⅜ inches by 4¾ inches, spaced 25 inches center to center, the camber being 6½ inches in 32 feet. The texas is finished in redwood, while the sash for the windows is of mahogany.

Hull

The steel hull is divided into six compartments by transverse bulkheads, three being watertight and two non-watertight. The peak bulkhead at frame No. 6 is made up of 10-inch plate, stiffened in a vertical direction by 3½-inch by 2½-inch by 6.1-pound angles, and in a horizontal direction by 2½-inch by 2½-inch by 4.1-pound angles. The plating of watertight bulkheads at No. 26 and No. 66 runs from 12½ pounds below to 6 pounds above. Horizontal and vertical stiffeners are all 2½ inches by 2½ inches by 4.1 pounds. The bulkhead at frame No. 44 is non-watertight and separates the boiler from the engine space. It is built up of 6-pound plate stiffened vertically by 2½-inch by 2½-inch by 4.1-pound angles, and horizontally by 3½-inch by 2½-inch by 7.2-inch angles. The engine space is separated from the after hold by a non-watertight bulkhead at frame No. 55. It is built up of No. 14 B. W. G. plate, and stiffened vertically and horizontally by 2½-inch by 2½-inch by 4.1-pound angles. Double angles are used in connecting the watertight bulkheads to the shell, while single angles are used for those that are non-watertight. Diamond-shaped liners are fitted to all bulkheads in way of outside strakes of plating. There are two coal bunkers, placed on opposite sides of the ship, and having doors that open into the fire-hold. The starboard bunker extends from frame No. 36 to No. 44, and the port bunker from No. 26 to No. 35. The bunkers are built up of 6-pound plate, stiffened vertically by 2½-inch by 2½-inch by 4.1-pound angles spaced 24 inches heel to heel. The boiler casing consists of 6-pound flanged plate built up from 10-pound coamings. The plates are flanged the necessary depth to do away with the angle stiffeners. The shell plating includes the garboard strake of 11 pounds fore and aft, bilge and bottom plate 10 pounds fore and aft. Strake next below the sheer strake 11 pounds fore and aft, while the sheer strake is 12 pounds for two-thirds length amidships reduced to 11 pounds at the ends. The keel plate is flat, being 30 inches wide by 15 pounds fore and aft, and worked in lengths of not less than seven-frame spaces. The butts are double riveted; a single inside 18-pound strap being fitted extending to the garboard edge laps. The garboard, bottom and bilge strakes are butt lapped, double riveted, ⅝-inch rivets being used. The side and sheer strakes are butt lapped, double riveted, ¾-inch rivets being used. The fore and aft edge laps of the garboard and sheer strakes are double riveted, the remainder are single riveted. The underbody of the boat is sheathed with rock elm, 2½ inches thick. The sheathing extends from between frames Nos. 15 and 16 to frames Nos. 66 and 67, and extends upward to the turn of the bilge. After the shell plating had been calked the wood sheathing was fastened in place by means of bolts and nuts and the bottom was then calked in the usual manner. The floors, 12 inches deep, are solid on every frame, being formed of 10-pound plates with the exception of the engine and boiler space, where they are increased to 14 pounds. Deep floors are provided for the engine space and also for the ends of the ship. The frames are formed of 3-inch by 2½-inch by 4.5-pound angles and spaced 24 inches heel to heel. The reverse frames forward and aft of the engine and boiler space are 2½-inch by 2½-inch by 4.1-pound angles, extending alternately to the main deck stringer plate and to the upper turn of the bilge. In the engine and boiler space they are increased to 5 pounds, and all extend to the main deck stringer plate, while additional reverse frames are fitted for the length of the floors.



SECTION THROUGH THE ENGINE ROOM

There are two longitudinal keelsons on each side of the center line, worked intercostal between solid floors on each frame. The longitudinals are formed of 10-pound vertical plates, whose lower edge is flanged and riveted to the shell, while the top edge is riveted to a 6-inch by 10.5-pound channel, which extends fore and aft over the tops of the floors, to which it is attached by angle clips.

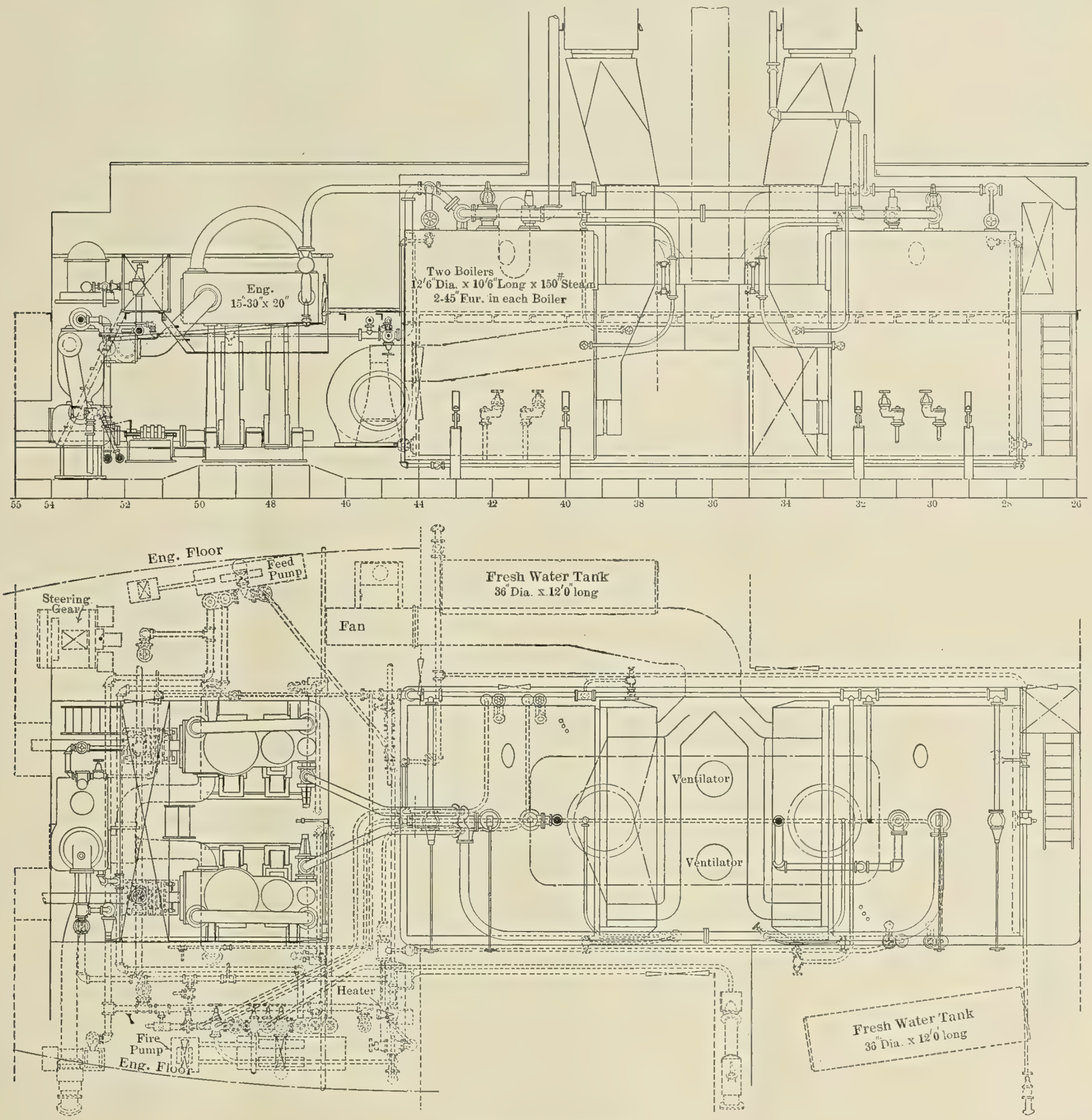
The channels are continuous fore and aft, and are not cut in the way of bulkheads. Bracket connections are made at all bulkheads, besides the necessary watertight construction. The longitudinals are carried as far forward as practicable and as far aft as the stern, where they help to stiffen the roof of the tunnel.

The bilge and side stringers are formed of a 6-inch by 10.5-pound channel, connected to the frames by 2½-inch by 2½-inch by 4.1-pound clips. The channels are slotted in way of the frames and cut at the bulkheads, to which they are attached by suitable brackets. The outer flange of the channel is connected directly to the shell, while the channel itself is fastened

to the frames by angle clips. At the stem the stringers are connected by 10-pound plate breast hooks, together with the necessary angles.

The foundation for the engines is formed mainly of four longitudinal girder plates, each of 10-pound intercostal between the floors, to which they are attached by means of double angles 2½ inches by 2½ inches by 4.1 pounds. The

The main deck beams are of angle steel, 5 inches by 3 inches by 8.2 pounds, placed on every frame, to which they are connected by 10-pound gusset plates 15 inches by 15 inches. The camber is 6 inches in 32 feet. The main deck stringer plates are 18 inches by 10 pounds for two-thirds length amidships, reduced to 8 pounds at the ends. They are fitted close to the sheer strake plating, and connected thereto by a 6-inch by



MACHINERY ARRANGEMENT

girder plate itself extends to the shell, to which it is connected thereto. The rider plates are continuous, and formed of 20-pound plates 15¾ inches wide, connected to the floor plates and longitudinals, thereby tying the whole together.

There are two saddles for each boiler, consisting of 14-pound plate and double angles 3 inches by 3 inches by 7.2 pounds. The fore and aft saddles for each boiler are connected by 14-pound plate girders, to which they are connected by 2½-inch by 2½-inch by 5-inch angles.

14.52-pound Z-bar. The top edge of the sheer strake is flanged outward to receive the lower flange of the Z-bar, while the deck stringer is connected to the upper flange of the bar.

The only plating on the main deck, other than that of the main deck stringer, is that due to the reinforcement of hatch openings in the way of boiler and engine space and stairways. The main deck is of pitch pine, 2¼ inches thick by 3¾ inches wide, laid in long lengths, and well fastened to the beams and plating by ½-inch diameter cheese head, square necked,

galvanized bolts and nuts. An oak fender strake, 6 inches by 8 inches, is placed on a line with the main deck and extends around the stern to as far forward as the stem.

Main Engines

There are two main engines of the two-cylinder, vertical, direct-acting compound type, well balanced, and each capable of developing about 500 indicated horsepower at 200 revolutions per minute, from a steam pressure of 150 pounds per square inch. The sequence of cylinders, beginning forward, is high-pressure and low-pressure, with diameters, respectively, 15 inches and 30 inches and a common stroke of 20 inches.

The main engines are placed 8 feet apart in a single engine room without a center line bulkhead, the starting platform being very conveniently located between the engines, with ample space for the engine crew to work in. The cylinders are fitted with safety valves in the bottom and covers. From the center of the engines to the center of propeller is 62 feet 6 inches. The cranks are set at 90 degrees. The high-pressure cylinder has one piston valve, 9 inches in diameter, while the low-pressure cylinder has a flat, double-ported slide valve, 28 inches wide and 24 inches long, the valve travel in each case being 4¼ inches.

The valves are operated by Stephenson's link motion through overhung double-bar links, whose motion is derived from eccentrics keyed to the crankshaft. The valve gear is so adjusted that the mean cut-off in full gear will be about 66¾ percent in the high-pressure cylinder and 56¼ percent in the low-pressure cylinder. The point of cut-off will be variable by means of slotted reverse arms. The pins on the links for the attachment of the eccentric rods are 24¼ inches center to center, the full throw of the links being 12 inches. The high-pressure eccentric sheaves are of cast iron and made in one piece, while the low-pressure sheaves are made in halves. The straps for all the eccentrics are of cast iron and made in halves, the bearing surface in each being 2¼ inches wide. The distance from the center of the shaft to the center of the links is 50½ inches. The valve stems in all cases are 1½ inches in diameter through the valves, 2 inches in diameter through the stuffing boxes and 2¼ inches at the guides. The piston rods are each 3¼ inches diameter.

The framing of each engine consists of two cast iron I-section columns at the front and two cast iron box section columns at the back. The bed plates are of cast iron and contain three bearings each. The exhaust passage from the high to the low-pressure cylinder is formed by an 8-inch extra heavy steel pipe, bent to the arc of a circle and connected by means of flanges to the upper facing of the steam chests, as illustrated in the general arrangement of the engine. From the inboard side of each low-pressure steam chest a steel exhaust pipe leads to a cast iron fitting bolted directly to the condenser, which is common for both engines. Each exhaust pipe has a diameter of 11 inches at the cylinder and 12 inches at the condenser.

The high-pressure pistons are of cast iron fitted with cast iron plugs arranged for water grooves. The low-pressure pistons are of cast steel fitted with the usual arrangement of cast iron follower and two spring rings in each piston. All pistons have a depth of 4½ inches.

The crossheads are of cast steel with pins 4 inches in diameter by 5½ inches long. Brass slippers are fitted for both ahead and astern thrusts. The slipper for the ahead thrust is 10 inches wide by 12 inches long, while the combined width of the slipper for the astern thrust is 6 inches with a length of 12 inches. The crosshead backing guides of L-section are made of cast iron and bolted directly to the back columns.

The connecting rods, which are 45 inches center to center, have a diameter at the crosshead end of 3¼ inches and 3¾ inches at the crank end. The crosshead end has a single connection, and the adjustment for wear at that end is taken up by means of a wedge, while at the crank end a bolt connection is used.

The crankshafts are each made in one forging with a coupling disk 14½ inches diameter by 1⅞ inches thick at one end. The length over all is 7 feet 1½ inches. The journals are 6¾ inches diameter, while the crank pins are 6¾ inches diameter by 8 inches long.

The crank webs are 7¾ inches wide by 4¾ inches thick. Opposite each crank slab a tail piece is forged, to which the cast iron counter-balances are bolted. The counter-balances are of sufficient weight to take care of the reciprocating as well as the rotating weights. Each thrust shaft is 6¾ inches diameter and 37 inches over all, being fitted with four collars 13 inches diameter by 1⅜ inches thick and 3½ inches apart. A coupling disk is forged on each end 14½ inches diameter by 1⅞ inches thick.

There are two intermediate shafts for each engine, 6¾ inches diameter by 12 feet 9¼ inches long, and coupling disks forged at each end. The tail shaft is 7¼ inches diameter in the bearings and 6¾ inches diameter between the bearings and at the ends. Length over all is 30 feet 3 5/16 inches. A cast iron coupling disk, 18¾ inches diameter, is shrunk on the forward end.

Each crankshaft has three bearings 6¾ inches diameter, two being 8 inches long and one 11¾ inches. The thrust bearings consist of cast iron pedestals fitted with three cast iron horseshoe collars lined with white metal in each pedestal. The intermediate shafting for each engine will be carried by two spring bearings made of cast iron, the lower halves being lined with white metal. Each propeller shaft will be supported at the outboard strut and also in the stern tube by a bearing at each end. The bearing in the strut will consist of a brass sleeve 22 inches long carrying wood strips of lignum vitæ. The after bearing in the stern tube is a duplicate of the strut bearing, while the bearing at the inboard end consists of a brass sleeve.

The stern tube is made of two cast iron sleeves connected by a standard steel pipe 9 inches diameter. The after sleeve is made to fit a cast steel boss riveted to the shell of the ship, while the inboard end is flanged to receive the after collision bulkhead. The over-all length of stern tube is 14 feet 5 inches.

There are two propellers of cast iron, solid, three-bladed, and made to the right and left hand. The diameter of each wheel is 6 feet, while the pitch is 9 feet, and the developed area for one wheel is 14½ square feet. The propellers rotate outboard.

Auxiliary Machinery

All auxiliary machinry is placed below the main deck with the exception of the dynamo and hand deck pump, which are placed on the main deck.

Reversing Gear—A steam cylinder, 7 inches diameter and 12 inches stroke, is used for reversing each engine, and is bolted directly to their respective front columns. A slide valve of cast iron governs the action of this cylinder.

Air Pump and Jet Condenser—A single-acting, independent, vertical air pump and jet condenser is fitted, having one steam cylinder 12 inches diameter placed directly over the air chamber, 24 inches diameter, with a common stroke of 18 inches. The diameter of the injection pipe is 5 inches, while the overboard discharge pipe of the air pump is 10 inches. All independent pumps are furnished by the Dean Bros. Company, Indianapolis, Ind. The air pump is placed athwartship, the center being 9 feet 5 inches aft of the center of the engine, the base resting upon the ship floors.

Feed-Water Heater—The feed-water heater is located on the starboard side on the forward engine room bulkhead, and

uses the auxiliary exhaust steam. This heater is a No. 5 Schutte & Köerting film feed-water heater, consisting of eight spirally corrugated tubes, 2⅜ inches diameter by 46 inches long.

Feed Pump—There is one 10-inch by 6½-inch by 12-inch independent, simplex, plunger, horizontal feed pump. It is located on the port side of the engine room, and has a discharge of 2½ inches diameter, while the suction connects with a 4-inch two-valve manifold, which draws from the hotwell and sea.

General Service Pump—There is one 8-inch by 5-inch by 12-inch independent, duplex, plunger, horizontal general service pump placed on the starboard side of the ship. The suction of this pump is connected to a 4-inch three-valve manifold, which draws from the sea, bilge and hotwell. The discharge, 2½ inches diameter, is connected to the general service pump manifold, through which the pump discharges indirectly to the ash gun, fire hose, deck hose, engine hose, condenser, overboard, fresh-water tanks, to the boilers through the feed-water heater and to the boiler direct through independent lines. A No. 14½ Model O Metropolitan injector discharges into the after end of this manifold.

Fresh-Water Pump—There is one 4-inch by 3¾-inch by 5-inch independent, duplex, piston, horizontal fresh-water pump placed on the starboard side of the ship on the forward engine-room bulkhead. The suction and discharge are, respectively, 2 inches and 1½ inches. The suction and discharge are connected to the fresh-water tanks, which are placed in the boiler room.

Sanitary Pump—There is one 5½-inch by 5-inch by 5-inch independent, duplex, piston, horizontal sanitary pump placed on the starboard side of the ship, and whose suction is taken from the sea. The suction and discharge are, respectively, 3 inches and 2 inches.

Bilge Pumps—There are two independent, horizontal, plunger bilge pumps, 4½ inches diameter by 4 inches stroke, each pump deriving its motion from a pin driven into the forward end of the crankshaft. The pump body is bolted to the outboard side of the bed plate of each engine, the suction, 3 inches diameter, is connected to the bilge, while the water is discharged through 2½-inch pipes directly overboard.

Steering Engine—There is a double-cylinder 5-inch by 5½-inch steering engine, steam and hand combined, made by the Hyde Windlass Company, Bath, Me., and placed on the port side of the ship, connecting with the rudder quadrant by means of chains.

Dynamo—There is a 25-kilowatt Crocker-Wheeler generator direct connected to a Terry steam turbine, which furnishes current for lighting the ship. This outfit is placed on the main deck, starboard side, just off the engine platform. The switchboard is placed on the port side near the entrance to the engine platform, the whole being within the engine well.

The distribution of lights is as follows:

Boat Deck—Ten 8-candlepower, five 16-candlepower, four 32-candlepower signal lights.

Main Deck—Fifty-seven 8-candlepower, forty-five 16-candlepower.

Promenade Deck—Seventy-nine 8-candlepower, eight 16-candlepower.

Hold—Thirty-seven 8-candlepower, thirty-six 16-candlepower.

Fan and Engine—The fan and engine used in connection with the forced draft for the boilers is placed on the port side of the engine room at the forward engine-room bulkhead. The 5-inch by 5-inch high-pressure engine is direct connected to a No. 6 Sirocco fan, both being furnished by the American Blower Company, of Detroit, Mich.

Ash Gun—The ash gun is placed at the starboard side of the ship on the forward side of the coal bunker bulkhead. This gun consists of the hopper into which the ashes are thrown, and there discharged overboard through a 7-inch extra heavy pipe, check valve and deflector, which is riveted to the side of the ship. A water jet at the top and bottom of the gun furnishes the necessary power to discharge the ashes.

Hand Pump—There is one vertical, duplex, plunger hand pump, required by the United States laws, placed on the main deck aft. Each cylinder is 4¾ inches diameter, with a stroke of 6 inches, making a total capacity for each cylinder 106 cubic inches.

Boilers

Two single-ended Scotch boilers of the cylindrical type, working at a pressure of 150 pounds to the square inch, are located on the center line of the ship in one boiler room. The distance apart of the boilers longitudinally is 9 feet 9 inches between the furnace fronts, while each boiler has a separate funnel spaced 12 feet apart. The funnels are 40 inches inside diameter, while the outside stack is 48 inches diameter, the top being 40 feet 3 inches above the grates. The boiler aft projects through the bulkhead between the boilers and engines about 3 inches. There is an exit to the main deck at the forward end of the boiler room. Ventilation for the boiler room is provided by two 24-inch ventilators placed in the center of the boiler room, and whose outlets are carried down to a height level with the bottom of the air heater.

The furnaces, two in each boiler, have internal and maximum diameters of 45 inches and 48 15/16 inches, respectively, the thickness being 15/32 inch. The grates are 5 feet 6 inches long, the grate surface of each boiler being 41¼ square feet, while the heating surface in each boiler is 1,713 square feet, or a ratio of 41.5 to 1, making for the two boilers an aggregate grate surface of 82.5 square feet and a total heating surface of 3,426 square feet. The furnaces are of the Morison suspension type, and have independent combustion chambers. The length of the tubes between the tube sheets is 6 feet 10 3/16 inches, and they are spaced 3½ inches in a vertical and 3¾ inches in a horizontal direction. Each boiler contains 326 tubes, of which forty-four are stay tubes; all have an outside diameter of 2½ inches, with a thickness of No. 10 for the stay tubes and No. 12 for the ordinary tubes. The tube sheets have a thickness of ⅝ inch. The top of the combustion chamber, which is 9/16 inch thick, is supported in the usual manner by bridge girders. The boiler shell is 15/16 inch thick.

The positive forced draft unit consists of a No. 6 Sirocco fan, direct connected to a 5-inch by 5-inch high-pressure engine, the whole being furnished by the American Blower Company, Detroit, Mich. The suction of the fan is taken from the engine room, while the air is discharged through a 24-inch by 24-inch galvanized steel pipe to the air heaters, which are studded to the boiler fronts. The suction of the fan has a diameter of 31¾ inches, while the discharge has a sectional area of 576 square inches. The air heater for each boiler measures 9 feet long by 2 feet 8 inches wide and 5 feet 2 inches deep. Each heater consists of 127 horizontal tubes, whose ends are expanded into steel plate headers, ¼ inch thick. All the tubes are of steel, 2¼ inches outside diameter, No. 14 gage, and 9 feet long. The total heating surface for both air heaters is 1,346 square feet. The operation of the positive draft is such that the burnt gases from the boiler pass by on the outside of the air-heating tubes, while the fresh air for the furnaces is forced through the tubes, thus abstracting heat from the boiler gases for the benefit of combustion.

Correction.—On page 396 of the October issue it was erroneously stated that the Diesel-engined Standard Oil barge *No. 62* made a trip from New York to Providence, R. I., in 11 hours. The correct time was 23 hours.

The First of the Eight New American-Hawaiian Steamers

In anticipation of additional business after the opening of the Panama Canal, the American-Hawaiian Steamship Company of New York has placed with the Maryland Steel Company, Sparrows Point, Md., an order for eight ships similar in character to the *Kentuckian* and *Georgian* (see Vol. XV, page 399) now in service. The placing of such a large order with one firm is unprecedented in the annals of American shipbuilding.

The route on which these vessels are to be placed is from New York to San Francisco and the Hawaiian Islands by way of the Panama Canal. Special attention has been paid to the arrangement of hatches for shipping large timbers. After the Canal has been opened to the marine traffic of the world, the owners will insulate the upper 'tween decks for the purpose of carrying tropical fruits, the builders having created a suitable steel house on the shelter deck ready for the installation of the refrigerating machinery.

The owners specified one radical departure from their previous boats. They desired to take advantage of the decrease in weight that the longitudinal system of framing allows and thereby increase the earning power of the ships. All eight vessels are to be built on the Isherwood system, the company also recognizing the advantages gained by clearer holds, besides increased dead weight.

The *Minnesotan,* the first of the order to be launched, made her initial trip down the ways on June 8, followed by the *Dakotan* on August 10. The *Minnesotan* went on the builders' trial on September 10 and left the following day for New York to be delivered. The principal dimensions of these boats are: Length between perpendiculars, 414 feet 2 inches; beam molded, 53 feet 6 inches; depth molded to shelter deck, 39 feet 6 inches; depth molded to upper deck, 31 feet 6 inches. The vessels are built to the highest requirements of Lloyds under special survey and are classed 100 A-1. The ships will carry 9,450 tons of dead weight on a draft of 28 feet and maintain a service speed of 12 knots.

All have straight stems, elliptical sterns, three continuous steel decks with an additional steel orlop deck in No. 1 hold. The propelling machinery is located amidship, just forward of which is a deep tank with an oiltight center line bulkhead for carrying either coal, cargo or fuel oil. At each end of the ship is located a peak tank for carrying fuel oil or water ballast. The double bottom extends the entire length of the boat with an oil-tight center keelson, and is divided longitudinally into eight tanks, the three under the machinery space being intended for carrying feed water. Oil wells are built in to separate these tanks from the remainder, which are to be used for fuel oil or water ballast.

When it is decided to use coal instead of fuel oil in the boilers, the coal will be carried in a bunker on the second deck abreast the machinery space and in the deep tank. The combined bunkers have a capacity of 900 tons. A steel shaft alley is built in the two after holds, extending from the machinery space to the after peak bulkhead. The ship's stores are carried at each end of the second deck over the peak tanks.

The vessels are fore and aft schooner rigged, with two steel masts and four king posts. The masts have eight booms each, one on the foremast being of 30-ton and one on the mainmast of 20 tons capacity. All other booms are capable of handling 5 tons. Each forward king post is fitted with two booms and the after ones with one each; the king post booms are of 3 tons capacity. All cargo booms are of seamless steel tubing imported from the Mannesmann Tube Works, Dusseldorf. To facilitate the handling of freight, four cargo ports are fitted to the lower 'tween decks and six to the upper 'tween decks. On each deck are six large hatches with wooden covers, and in addition numerous small trimming hatches are distributed throughout on the upper and second decks.

The deck machinery is composed of a Hyde vertical wildcat pattern steam windlass with the engine on the deck below. Warping heads are fitted above the wildcats. Four double-geared and ten single-geared winches with single drums and gypsy heads are installed for handling freight; the winches have 9-inch by 14-inch double cylinders. Two heavy steam dock capstans with 9-inch by 9-inch cylinders are also fitted on deck, one forward and one aft. The steering engine is a Hyde geared quadrant type operated by means of a Brown telemotor from the pilot house, the flying bridge and the steering engine room. The engines are twin vertical engines, each capable of handling the rudder under any condition. The deck equipment consists of two 26-foot metallic lifeboats, one wooden 20-foot cutter and one wooden 22-foot gig. All boat davits are Norton's patented screw gear type.

The accommodations for the passengers, officers and crew are large and airy, the aim being to make the quarters as comfortable as possible, as a considerable portion of each trip is in the tropics. The quartermasters, carpenter and boatswain are quartered in the forward end of upper 'tween decks. Their stores, lamp room, wash and toilet room are forward. At the after end of the upper 'tween deck the watertenders, oilers, seamen, firemen, wash and toilet rooms are installed.

The midship house contains the dining saloon and pantry, the officers' mess room and pantry, two spare staterooms, store rooms, accommodation for the freight clerk, cooks, steward, mess boys, chief, first, second, third, deck and refrigerating engineers, and bath and wash rooms. In a steel house at the after end of the shelter deck the hospital with bath and spare staterooms are fitted.

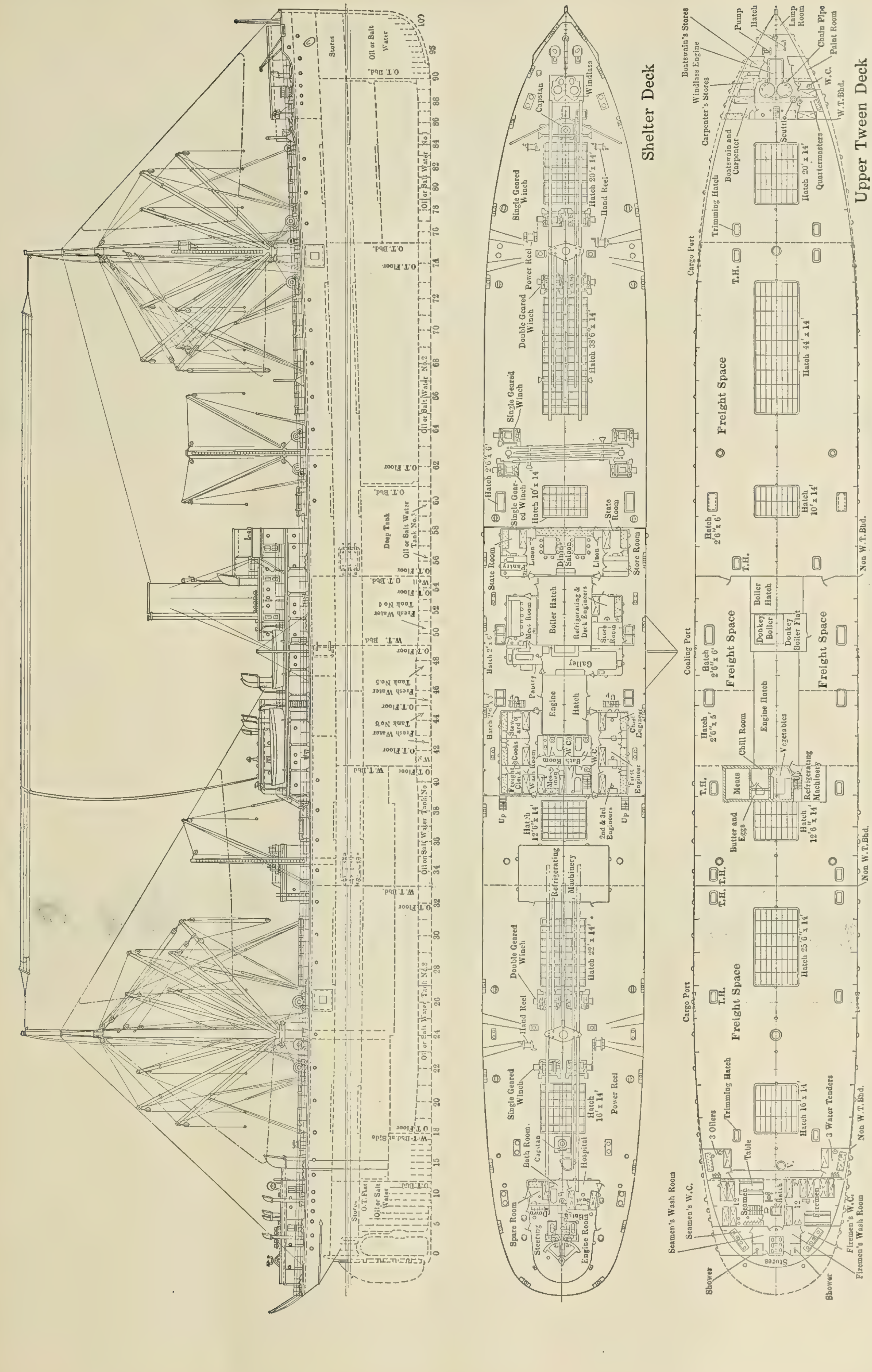
On the boat deck are located four staterooms and bath, the wireless room, pilot house, chart room, first, second and third officers, officers' bath and the captain's stateroom, office and bathroom. At each of the lower 'tween decks special freight rooms are bulkheaded off for bonded freight.

The propelling machinery in the *Minnesotan* is similar in design to that installed in the steamers *Kentuckian, Georgian* and *Honolulan,* and consists of one 4-cylinder quadruple expansion engine, three single-end Scotch type boilers and the necessary auxiliaries.

The main engine cylinders are 25½ inches, 37 inches, 53½ inches and 76 inches in diameter by 54-inch stroke, having piston valves throughout, and are supported by heavy box columns fitted with double slipper guides. The main air pump, two bilge pumps and an oil pump for forced lubrication to thrust block, are attached to the high-pressure engine. The crank shaft is 15¼ inches in diameter and is in four interchangeable pieces, the cranks being set at equal angles.

The propeller, which is 15 feet 6 inches diameter by 18 feet 6 inches mean pitch, has a cast steel hub with manganese bronze blades. The main boilers are 16 feet mean diameter by 12 feet 3 inches long, designed to meet the requirements of Lloyd's inspection rules for 215 pounds working pressure. Each boiler contains four 41-inch inside diameter corrugated furnaces. The tubes are 2¾-inch diameter and the total heating surface is 3,173 square feet per boiler.

The boilers extend through the engine room bulkhead and have all connections on the back heads in the engine room. They are fitted with the Howden's system of forced draft and are built to burn either oil or coal as fuel. It is the intention to burn oil for the greater part of the time, but all the necessary grate bars, etc., are carried so that the change



GENERAL ARRANGEMENT PLANS OF THE AMERICAN-HAWAIIAN STEAMSHIP MINNESOTAN

to coal may be made at any time. When burning oil the steam atomization system is used with the necessary pumps, oil heaters and filters, etc., carried on the forward fire-room bulkhead. The fuel oil system throughout is furnished in duplicate. The donkey boiler is 10 feet diameter by 9 feet 6 inches long, built for 315 pounds per square inch working pressure and to burn either coal or oil fuel.

There are also provided two long-stroke simplex feed pumps, a duplex fire and bilge pump, an oil trim pump, a duplex ballast pump, a fresh water pump, an auxiliary condenser with attached air and circulating pumps for port use, a 14-inch centrifugal circulating pump, two 20-ton evaporators with pump, two distillers with pump and serrating tank, a forced draft blower, a 2-ton refrigerating plant and a multi-coil feed heater. A drill press, a lathe and an emory wheel are installed on the starboard side in the engine room and are operated by an electric motor.

A system of mechanical ventilation for the cargo holds has been installed with two motor-driven fans located in the engine casing.

An Installation of Fire Extinguishing and Fumigating Apparatus

One of the few menaces to safety on board ship at sea which has not been entirely overcome in modern steamship construction is the danger of fire. In spite of the careful consideration which is usually given to fireproof construction instances are not infrequent where enormous losses of property and sometimes of life occur from this cause, and the difficulties of fighting fire in the hold of a ship laden with an inflammable cargo are clearly recognized by experienced seamen and marine engineers. Fire has been known to smoulder for days and weeks in a ship's hold while the crew has been unable to check it, and even when checked the ordinary means of fighting fire at sea invariably damage such of the cargo as is not destroyed by the fire itself. Water and steam are the common weapons used for this purpose, but a cargo hold can seldom be flooded with water without impairing the safety of the vessel, and the use of steam has not proved as effective in practice as it would appear to be in theory. These facts are conceded by experienced fire fighters.

On the other hand, the value of sulphur dioxide gas as a fire extinguisher has been known to engineers and scientists for many years, and the efficiency of the same gas for fumigating purposes has been admitted by the best authorities for over 2,000 years. The generation and application of this gas, therefore, have been the subject of study and experiment for generations, the object being to produce it in volume so that it can be delivered in quantities sufficient to do its work without damaging the things with which it comes in contact. This, it is claimed, has been accomplished by a machine known as the "Grimm" sulphur dioxide gas machine, manufactured by the Fumigating & Fire Extinguishing Company of America, New York. A detailed description of this machine was published on page 125 of the March, 1912, issue of International Marine Engineering, and it will be remembered that by this method commercial sulphur, or "rolled brimstone," as it is known to the trade, is put into a furnace into which the air is forced in such quantities as to form perfect combustion, the continuance of which is dependent only upon the periodical supply of sulphur, which is accomplished by means of a patented device on top of the machine through which no sulphur fumes can escape. This furnace is placed inside a water-jacket of rectangular form, constructed in the manner of a marine boiler, through which water is circulated during its operation. The gas is forced from the "dome" of the furnace by its elasticity, and after passing through cooling tubes in the water-jacket is then discharged from the machine in a cool and dry condition, whence it is conveyed through a pipe or hose to its destination. Such, briefly, is the operation of the apparatus.

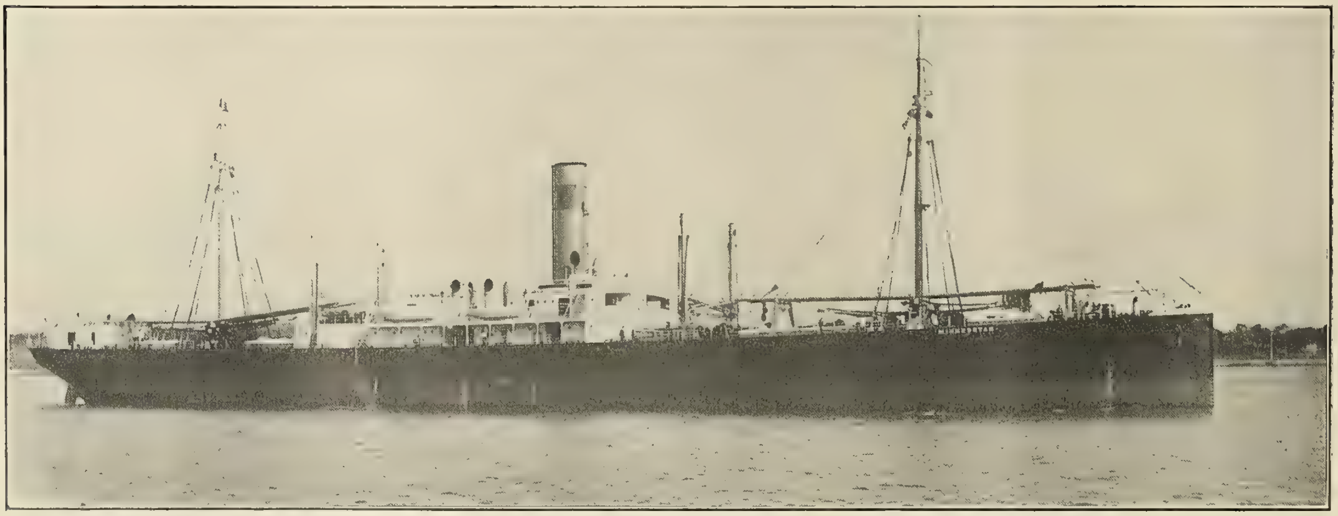


FIG. 1.—NEW AMERICAN-HAWAIIAN STEAMSHIP MINNESOTAN

Its value to a steamship owner is clearly evident when it is realized that the gas thus generated will extinguish fire without damage to cargo. At the same time the installation of this apparatus on a steamship insures the vessel a clean "bill of health" the world over; for not only is the ship protected against fire by turning the gas into any compart-

ment or hold where a fire may occur, but the entire ship, or any part of it, can be effectually fumigated without recourse to the makeshift apparatus supplied by quarantine officers, most of which is obsolete. The operation of this apparatus has shown by experience to be capable of entirely freeing a

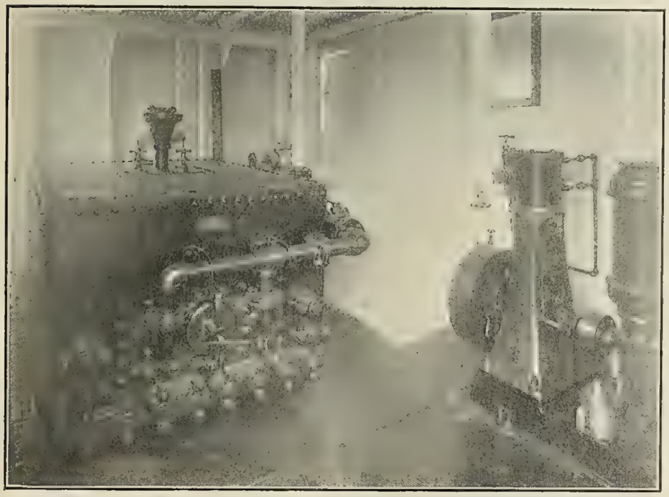


FIG. 2.—FUMIGATING AND FIRE EXTINGUISHING APPARATUS ON THE MINNESOTAN

ship of the presence of rats, insects and disease germs, thus eliminating some of the most troublesome and dangerous hardships of the crew and ocean travelers.

As an illustration of the application of this apparatus to a modern steamship attention is called to the accompanying illustrations, which show the new American-Hawaiian steamship *Minnesotan*, one of the eight new vessels now being constructed for this company by the Maryland Steel Company to take advantage of traffic through the Panama Canal. All of these new ships are being equipped with this apparatus in the manner shown in Fig. 3. The gas machine is placed in a steel deckhouse, 8 feet by 13 feet, on the upper deck just abaft the smokestack; from this a main discharge pipe, 3 inches diameter, extends on the starboard side of the vessel forward and aft under the shelter deck. The main pipe leads to six manifolds, all of which are on the shelter deck, accessible at all times and securely protected, from which 2½-inch branch pipes extend to each deck in each hold of the vessel. All of the branch pipes lead to within 2 feet of the floor of the compartments. The vertical branch pipes are laid well up against the bulkheads, or against the face of the longitudinals or frames at the ship's side, and are securely protected with wood casings. All of the piping is of galvanized iron and fittings are avoided wherever possible, bends being substituted. While a separate pipe line for this gas is usually provided a combined gas and steam installation has been worked out in

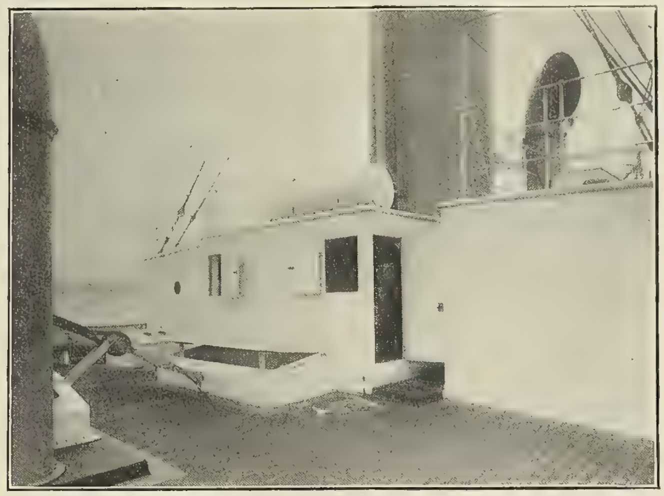


FIG. 4.—DECK HOUSE, WHERE FUMIGATING AND FIRE-EXTINGUISHING APPARATUS IS LOCATED

the case of the *Minnesotan*, but all pockets where condensed steam could collect have been eliminated, and there is always a fre flow for water to the drains provided, so as to keep the pipes as dry as possible for the gas. All of the branch lines are controlled by manifold valves, so that gas or steam may be forced into any compartment of the ship where it may be required, and, in addition to this, there are hose connections

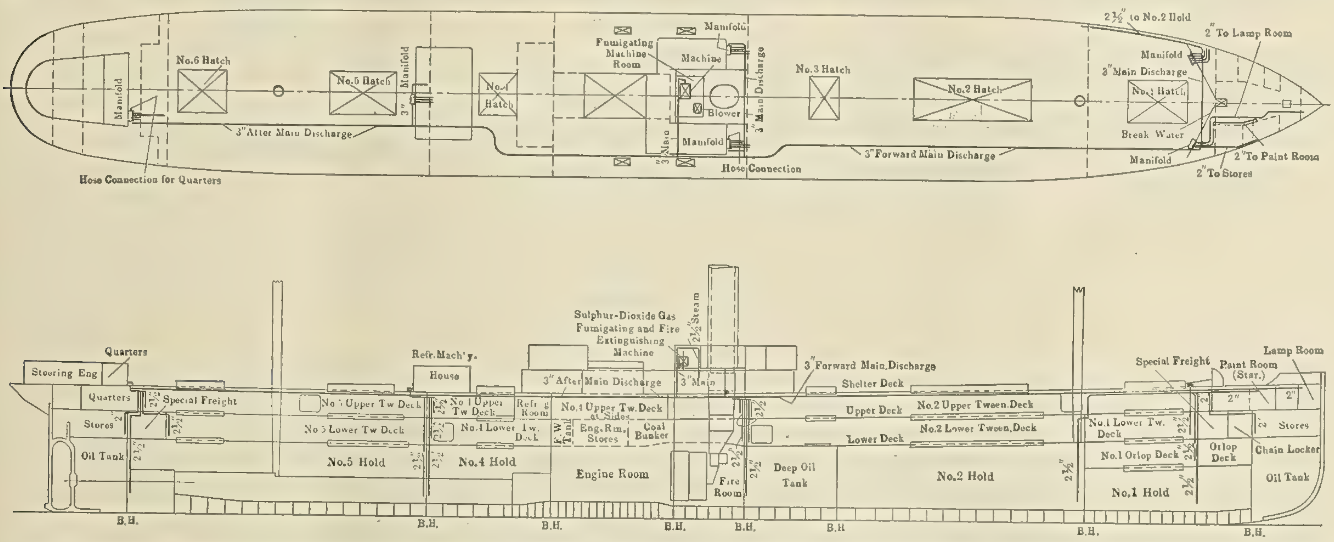


FIG. 3.—PROFILE AND SHELTER DECK PLAN OF THE MINNESOTAN, SHOWING ARRANGEMENT OF PIPING FOR THE FUMIGATING AND FIRE-EXTINGUISHING APPARATUS

forward and aft, so that gas may be used for fumigating the crew's quarters.

One of the features of this equipment which will appeal to the engineer, is that the gas is not drawn from the machine through pumping apparatus, but that only air is pumped, and that into the furnace where the gas is generated; thus the gas is discharged under pressure, so that it does not come into contact with the blower outfit.

Besides the installations on the new American-Hawaiian steamships, the Panama Steamship Line and the Hamburg-American Steamship Company (Atlas Line service), and many others, use this apparatus. Smaller sets have also been supplied for shore use at Newark, N. J., Havana, Cuba, and elsewhere.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Attachment of Piston to Rod

That part of the interesting narrative, "Total Breakdown of High-Pressure Engine"—October issue—relating to the difficulty experienced in getting the piston off the rod, caused me to wonder why engine builders continue to fit pistons on tapered rods, when it is known to be extremely hard to get them off after they have been in service for some time. Of course, it is also well known that marine engines have to endure serious stresses and shocks at times, and therefore all the parts must be designed, built and assembled with that understanding. But pistons do break occasionally, or something else gives out which necessitates removing the piston from the rod, and then the trouble begins, as related in F. J. S. N's story, to which I refer.

The taper-fit idea is all right in principle, and would be all right in practice if the taper were of the *correct* inclination.

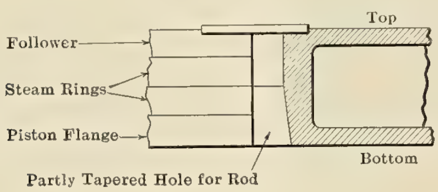


FIG. 1

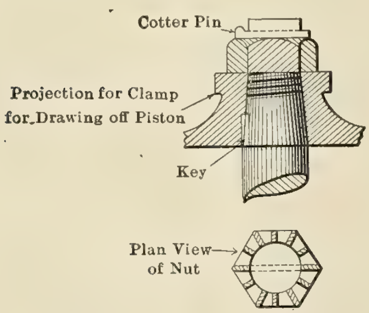


FIG. 2

If a taper is too "steep"—as shop parlance states it—it will not have any holding force, and dependence must be placed solely on the nut to secure the piston on the rod. On the other hand, if the taper has too little angle of inclination it may secure the piston so tightly to the rod that under conditions existing on board ship at sea it becomes almost impossible to get the piston separated from its rod. From the description given it would seem that the piston in the story was fitted on a taper that was of too little angle of inclination, and that probably was the reason the rod could be shoved further into the eye of the piston without splitting it. This could not have happened had the taper been too "steep."

Between the extremes of tapers alluded to there is one that serves the purpose of securing the piston to the rod, yet at the same time permits the piston being disengaged whenever and wherever it may be found necessary to do so. In order to find just what this taper is in any given case, it must first be found out what the angle of repose is for the metals of which both piston and rod are made. When the angle of repose is known, then a taper can be chosen that will not "stick" at a time when it is required to remove a piston under adverse circumstances, and under conditions when time is very valuable and must not be wasted in useless efforts.

Probably the majority of engine builders do consider the angle of repose feature when devising tapers for piston and other rods. But it is nothing uncommon to hear of just such trouble as recorded by your correspondent, and I wonder if in such cases the angle of taper was guessed at. In any case, the piston should be fitted so that it may be removed with ordinary means, and not as if it were never to be disconnected from its rod at all.

Pistons with eyes bored parallel and fitted on corresponding rods, as shown in the accompanying sketch, Fig. 3, have been used in stationary practice with satisfying results, and why not expect that they would also do in marine practice if properly designed otherwise? Here the piston is a sliding—not a loose—fit, and it is held securely against a shoulder on

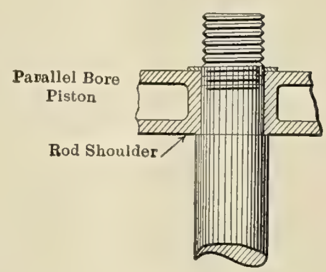


FIG. 3

the rod by a nut, as in the case of all pistons; the nut in turn is secured against slacking back by one of several devices well known. This makes a solid job, it is easily handled, and the piston can be taken off at any time without any trouble, as is frequently encountered with those represented in Figs. 1 and 2, when the tapers are not made in accordance with the angle of repose. What is the opinion of other engineers on this matter? Charles J. Mason.

Scranton, Pa.

Efficieny of Turbines at Cruising Speed

With reference to the letter which appeared in a recent issue under the above heading, it may be of interest to trace the development of turbine arrangements with regard to their economy at cruising speeds.

The first turbine-driven vessels built (with the exception of the experimental *Turbinia*) were the torpedo boat destroyers *Viper* and *Cobra*. Although these vessels attained very high speeds it was quickly realized that their economy at low speeds left much to be desired. On account of this, in the next vessel built (H. M. torpedo boat destroyer *Velox*) a pair of small reciprocating engines were fitted in addition to the turbines to operate at cruising speeds, so that the arrangement adopted in the *Henley* is by no means novel.

In the case of the *Velox* the arrangement was as indicated in Fig. 1, there being four shafts with the high-pressure turbines on the outer shafts and the low-pressure and astern turbines on the inner. A triple-expansion engine was coupled to each inner shaft forward of the low-pressure turbine, and could be thrown in and out of gear by means of a clutch.

This arrangement has never been repeated in the British navy, subsequent improvements with installations of turbines only having rendered its adoption unnecessary.

In order to improve the efficiency of turbine-driven destroyers at cruising speeds the arrangement indicated in Fig. 2 was adopted, there being three shafts, the high-pressure turbine on the center shaft and the low-pressure and astern turbines on the wing shafts, while cruising turbines were added to operate in series with the main turbines, the high-pressure cruising turbine on the port shaft and the medium-pressure cruising turbine on the starboard shaft. These cruising turbines were cut out of action successively at increased speeds. This arrangement was just installed in the British torpedo boat destroyer *Eden*, and up to very recently has been the standard for British destroyers. It has been quite successful as regards cruising economy, probably its greatest drawback (and one common to all cruising turbines) being a liability to blading strips if the clearances are cut fine and the turbines are not carefully handled.

As regards battleships and cruisers the British Admiralty have abandoned the cruising turbine, and secured the desired efficiency at cruising speeds by adopting turbines of greater economy at all speeds, and by fitting additional rows of blades

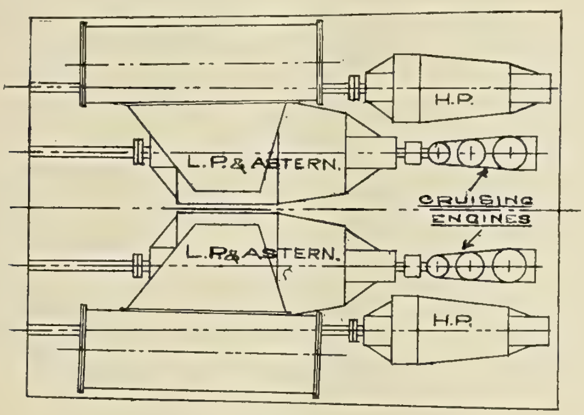


FIG. 1

(about twenty) at the initial steam end of the high-pressure turbine, this portion being by-passed at full speed. This arrangement has, the writer believes, been fitted to only one destroyer.

In the latest British torpedo boat destroyers, however, the three-shaft arrangement with cruising turbines has been definitely abandoned and twin screws adopted, each shaft being driven by a single turbine of the combined impulse-reaction type, with an astern turbine incorporated in the same casing. In this type of turbine the steam enters the nozzle boxes at 220-240 pounds per square inch, is expanded in the nozzles to about 70-80 pounds per square inch, passes through one velocity compounded wheel with four rows of moving blades, and thence through the remainder of the blading, which is of the usual Parsons reaction type. It is still too early for definite information as to the efficiency of this type of turbine, there being at present only the first two experimental vessels in service, but the fact that the British Admiralty have installed this system in their destroyers, and are also fitting it in scout cruisers, speaks for itself.

In addition several vessels have been fitted with twin-screw installations of turbines of the Curtis type. In these cases superheaters are used to obtain an efficiency equal to the Parsons system. Having thus traced the development of turbine installations in the British navy, as affecting efficiency at cruising speeds, we are in a position to consider further proposals.

In the first place one can only agree with Mr. Barry that an arrangement similar to that fitted in the *Henley* would be entirely unsuited to a battleship. Such an arrangement is only applicable to vessels of the destroyer type, where the rate of revolution is high, and the reciprocating engine can be made correspondingly small. The lower rate of revolution in a battleship would involve an engine of such dimensions as

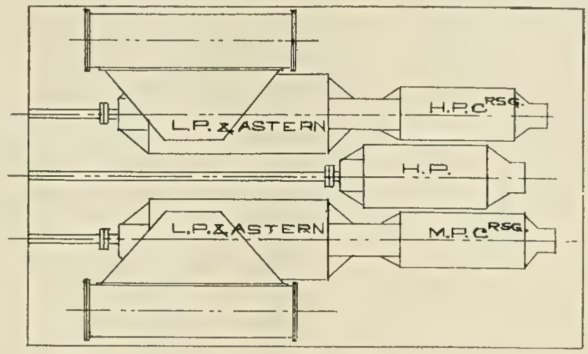


FIG. 2

to preclude its adoption. Mr. Barry has suggested the fitting of a clutch abaft the turbine, to be thrown out of gear and a two-to-one reduction gear substituted at cruising speeds. Mr. Barry points out that the power to be transmitted would be about 1,900 shaft-horsepower in the case of the battleship taken.

It would seem to the writer that some considerable experiment and trial would be necessary before an installation on such a scale could be reasonably attempted. A twin-screw torpedo boat destroyer would be a more suitable subject for experiment, as the power to be transmitted at cruising speeds would be about 500 shaft-horsepower. One disadvantage of this proposal is that the whole of the propeller thrust would have to be taken on the thrust block, the advantage of the steam balance of the Parsons turbine with its consequent freedom from thrust troubles being lost in such an installation, and it has been found that the provision of a block to take the whole of the thrust at the high revolutions of turbine machinery is somewhat difficult.

Mr. Barry's second proposal, to gear a small high-speed

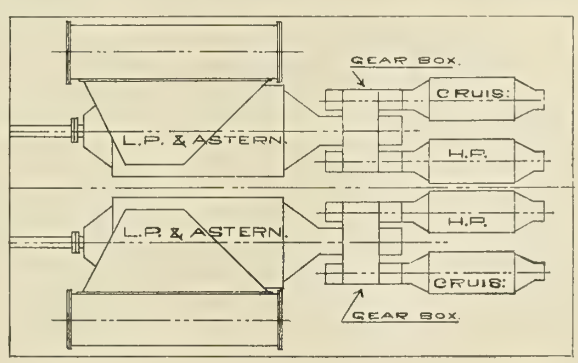


FIG. 3

turbine or reciprocating engine to the shafting forward of the main turbines and exhausting to them, appears to have more to recommend it. We may take it that if gearing is to be fitted the reciprocating engine need not be considered. Mr. Barry must not, however, imagine that this proposal is original, as Messrs. Parsons (who undoubtedly possess the largest experience on the subject) have proposed similar arrangements for some considerable time, and have at the present moment two destroyers completing on the Clyde for the British navy, these vessels being fitted with a system of

geared turbines which embodies their ideas, the arrangement being indicated in the sketch Fig. 3.

There are two main shafts, which run at about 600 revolutions per minute, and directly coupled to these shafts are the low-pressure turbines, in which are incorporated the astern turbines. Forward of each low-pressure turbine and connected to the main shaft through double helical gearing is a cruising turbine and a high-pressure turbine, the reduction ratio being such that with for 600 revolutions per minute of the main shafts the cruising turbine runs at about 3,000 revolutions per minute and the high-pressure turbine at 2,000. With this arrangement the safety of the installation is independent of the gearing, while the gearing admits the adoption of very small, high-speed, economical turbines to aid the efficiency at cruising speeds.

One of these vessels has already run trials on which a speed of about 30½ knots has been attained, the gearing being very free from noise except for a loud hum. The trials at cruising speeds indicate a remarkable degree of economy, for whereas the consumption of oil on the 24-hour trial at cruising speed has been (for the standard British torpedo boat destroyers) in the neighborhood of 18½ tons, the adoption of this geared arrangement has reduced it to about 14½ tons.

It would appear that an arrangement of this type is a more rational method of applying gearing, more especially in the initial stages of its application, as not only is the propulsion of the ship independent of a breakdown of the gearing, but in addition the thrust is equalized by the steam balance in the usual way.

The latest arrangement for securing economy at cruising speeds is the adoption of Diesel oil engines for use at low powers. These are thrown out of gear at higher speeds. With oil-fired vessels this would enable the steam arrangements generally to be almost entirely shut down under cruising conditions, so that a great increase in economy should result. The writer understands that a torpedo boat destroyer is being built for the British Admiralty with machinery arranged on the above lines, and the results of her trials will be looked forward to with great interest. Gearing.

The Diesel Electric Drive in the Tynemount

In your issue of October, 1912, on page 396, a notice appears regarding the Canadian canal vessel *Tynemount*, now building in England to the order of the Montreal Transportation Company, and which is to be fitted with oil electric machinery.

The proposed arrangement is one which was developed by me in co-operation with Mr. H. A. Mavor, as long ago as 1909, in order to enable the Diesel engine to be used for propulsion without interfering in any way with the usual type of propeller which is so essential for successful propulsion in the Canadian canal trade. In other words, it has been found that the Diesel engine, being naturally of a high-speed character, is best run at revolutions which cannot be reconciled with the slow-speed, coarse pitched type of propeller best suited to the full-formed canal vessel of the lake type for propulsion. Further, the go ahead and go astern motions required in any propulsion directly coupled to the propeller in negotiating the very numerous locks in the Welland and St. Lawrence channels are quite fatal to any type of internal combustion engine requiring compressed air for starting and reversing. In such rapidly alternating motions the cycle of operation on which the success of the Diesel engine depends is completely upset, the fuel injected into the cylinders is not properly burned and trouble incidentally results.

In the *Tynemount* the Diesel engines, coupled to their alternators, will run continuously in one direction only and under governor control furnishing power to the propeller motor keyed to the propeller shaft just ahead of the thrust block, and this motor will deal with the necessary speed changes and reverse being easily controlled by a very simple switching mechanism.

Very satisfactory results have recently been obtained in Schenectady in the plant of the General Electric Company, in a 6,000 horsepower outfit for the collier *Jupiter*, in which a Curtis turbine of the high-speed type was used to drive the alternator.

The scope for electric transmission in marine propulsion is clearly established and the combination Diesel electric installation in the *Tynemount* has created great interest. The *Tynemount* was ordered in England by the Electric Marine Propulsion Company, Ltd., and sold to the Montreal Transportation Company. It is being built under my supervision and to plans and specifications proposed and approved by my firm. John Reid

Montreal, Canada.

The Draftsman in Shipbuilding

The extracts from the paper under the above heading in your August issue provoke some thoughts about ship accommodation generally. The paper has much interest, but the sentences causing reflection are as follows:

"Spaces allotted to ———— living quarters are so small that much time is required after a contract is obtained to arrange them in a workmanlike design."

"Arranging and rearranging the berths and lockers in a space only half large enough."

Whosever the fault, the fact remains that in freight ships especially the accommodation for officers and engineers (not to mention the firemen and sailors) is usually cramped, badly lighted and infernally inconvenient.

The writer once asked for a transfer from a 10-knot freighter mainly on account of the lack of accommodation and convenience. He was duly informed that he was better off where he was, certainly than in the steamship ————, the third and fourth engineers in her had to practice gymnastic feats every time on their way to the engine room.

Conditions of life ashore in the way of accommodation are receiving considerable attention just now. Even the immoral speculative builder is now putting up quite small houses with some regard to domestic convenience. The United States has led the world in the provision for workmen in factories of conveniences in the way of lockers, washing and dining facilities. It is now an axiom of manufacturing that, other things being equal, the capable workman discriminates against a works lacking facilities and comfort. Large firms vie with each other in their care of employees; in short, the industrial conscience is slowly but surely awakening to the fact that money spent in this wise is a paying investment.

With regard to ships, and these not always freighters, elementary comfort for the crew is not studied in the manner it might be. There is no question but that space on a vessel is valuable, but certain anomalies exist and at little extra cost a great deal may be done.

Take any freighter running outward with coal to the Mediterranean and home with grain to the Continent under the British flag. It will be found that the skipper, naturally, has a good room, but the officers are debarred from the so-called saloon except at meals. This "saloon" is the only reasonable place on the vessel, but is the captain's private lounge. Sea etiquette (a survival from past ages) holds good in this particular to-day.

A berth 6 feet cube with one 8-inch portlight is in most instances considered accommodation for two certificated officers. Sleeping space occupies 65 feet cube, a locker athwartships, on which it is impossible to lie full length, and a

small chest of four drawers completes the outfit except for a fold-up washing basin. Considering that outside this room there is only the deck, I submit that the accommodation is inadequate for two men of their rank and position.

Engineers are a trifle better off. Not, however, in size of room, because of the small mess room in which it is possible to foregather. It was an engineer, however, who stated that to turn over in his bunk he had first to get out and open the door of his room.

A vessel (oil tank) in which the writer sailed, doing Western Ocean passages, had the rudder post through an unusually large messroom. The engineers, being berthed aft in what otherwise would have been vacant space, had really roomy quarters. The rudder post passed through the floor, and had no gland or stuffing-box to keep the water out. The existing bush was worn ½ inch slack, and you can't monkey with a rudder in mid-Atlantic. The condition of affairs in mid-winter in heavy weather can be easily imagined. To add to the beauty of the circumstances, the only store for provisions was under the messroom. A foot of water rolling in and out of our berths, a fountain playing every time the vessel sat in the water, combined with a tired-out mess steward vainly endeavoring to stem the tide, were not comfortable conditions any way you look at it. The particular ship was a very hard-run engine room job—always in trouble below. Two short trips were an excessive allowance for me, combined with a chief whom the job was rapidly fitting for an asylum.

Again, take the officers' accommodation. There is a bath room provided, but usually this again is the skipper's perquisite. I have been in ships where the mates had no chance of a satisfactory bath in spite of the provision of a bath room aft. The skipper held the key of the door.

The engineers' bath room, being unprovided with any water facility, is often kept as a store for packing—the engineers washing down below on the back platform. The provision of hot and cold water to the bath could be easily arranged. Even so a chief suffering from the not unusual malady of coal fever might prohibit its use on the ground of economy.

This all applies to freighters, where proper accommodation is easily arranged. Passenger vessels are better provided in spite of the increased value of space therein. The officers and engineers then share in the superior accommodation provided for the passengers.

I have been East through the tropics to China in a freighter where the engineers' accommodation was formed out of a portion of the 'tween deck bunker. Ventilation was impossible in any adequate sense. Each room had a 36-inch long cowl ventilator projecting from the main deck. The engine room superstructure cut off the wind from these ventilators if not blowing from the same side. Boiler room ventilators are carried up clear of the superstructure; but then boilers cost money and so does coal, and you cannot burn the latter without draft. Engineers can, however, be much more easily replaced.

Why not an adequate bath room amidships, available to all officers and engineers, situated close to the engine room; it could easily be arranged even if cold water were led in and simply heated with a steam jet. This would be little trouble when the ship is designed. A couple of hot spray baths for the crew would not cost a fortune, either.

It is rather a pity, and in this I agree with the author of the paper, that ship draftsmen do not get sea experience. In my humble opinion, while I fully appreciate the importance of their calling, six months, say, in the engine room would alter some of the poor accommodation now afloat in future ships.

One ship designer on the Northeast coast is known to me who holds British certificates of competency as engineer, and he has certainly improved matters in this direction for the inhabitants of the freighters turned out at the yard where he is employed. He informs me that it takes some scheming, but is not impossible to do, even where he encroaches upon the size of the sacred "saloon" to do it.

There is importance in this question to owners. The junior engineers and officers take considerable responsibility. The actual work in the engine room is entirely carried through by the juniors. It is desirable, therefore, that the most capable and brainy men on the market should be secured. Times and conditions of life are changing and ideas of comfort are becoming more considered. If the accommodation and conditions in a ship are good, a junior will think more than once before making a shift. The actual cost of providing decent accommodation in a new ship is trifling considered as a percentage of total cost, and such provision is worth while. The type of man known as a "one ship bird of passage" has little stake in your interests, "Mr. Owner." The type of man you are likely to get under modern conditions in such ships as I indicate are not desirable persons. No complaint reaches your ears; the good man simply gets out and you are the loser without knowing it.

In conclusion, I submit that reasonable space, fittings, ventilation and provision for personal cleanliness for officers and engineers, a comfortable, roomy, light forecastle and provision for personal cleanliness for the crew, sanitary in accordance with modern notions, are elementary matters costing little but which mean much. It should not be necessary to point this out. The best ships get the best men, and it is as well to forestall legislation on such matters as these.

London, England. A. L. Haas.

Steamboating on the Amazon

The steamer *Curityba,* one of fourteen American stern-wheel river boats, 125 feet long by 26 feet beam, 3 feet 6 inches depth of hold, built by James Rees & Sons Company, Pittsburg, Pa., and shipped in knock-down form to Para, Brazil, for service on the Amazon, left Para Aug. 23 for Rio Madeira to Porto Velho. On this trip the steamer traveled up several small tributaries en route from Para to Itacoatiara, the mouth of the Madeira, returning from Porto Velho to Manaos and then to Alto Purus and Acre Rios, carrying a rubber commission sent out from Europe. On leaving Para the boat was drawing about 32 inches of water at the head, and had coal, stores, etc., on board aggregating about 110 tons. She could have carried safely in quiet water 30 or 35 tons more. The average speed up the Amazon and Madeira until she reached very strong water was close to 8 miles an hour, which was reduced to 5 or 6 miles an hour over riffles. The coal consumption was, roughly, 5 tons per day. The boat handled very well in spite of the fact that the pilots and captain were natives, unfamiliar with this type of boat and with the methods of river boating in vogue on the Western rivers in the United States. The *Curityba* left Itacoatiara 24 hours behind another vessel, the *Francisco Salles,* operated on this route, and passed her twice on the river, beating her into Porto Velho by about four hours. The distance between the points named is about 750 miles. The *Francisco Salles* is a much larger boat, being 180 feet long by 33 feet beam, molded. She is a stern-wheel steamer, with cross-compound engines 18 inches and 38 inches diameter by 5 feet stroke, whereas the *Curityba* has high-pressure engines 9 inches diameter, 48 inches stroke. The usefulness of the stern-wheel boats on this river is evident, but it is a serious problem to find men who are capable of operating the boats to the best advantage.

Para, Brazil. An Ex-Mississippi River Pilot.

Review of Important Marine Articles in the Engineering Press

Diesel Engines for Naval Purposes.—By Lieut. A. K. Atkins, U. S. N. This is one of the most satisfactory contributions to the literature of Diesel engines in many months. Uninfluenced by the idea of gain, and without the prejudice of too long experience with steam, Lieut. Atkins weighs the merits of the Diesel engine for naval service, recognizing that steam is near the top of its efficiency and reliability curve, and that progress is pointing the way for this new motor to accomplish much more for speed, steaming radius and fuel-carrying capacity than is at present possible with any means. After reviewing the essentials in the development of types of Diesel engine practice, the author makes comparisons of motor service with examples of naval steam engine performance. The achievements of the former are now sufficient for such a comparison on every point of service. A résumé of reasons for and against the oil engine is carefully drawn up, which is a very sane statement of the situation. Too lengthy to be given here, even in condensed form, it is sufficient to say that for a careful summing up of the matter to the present time we have not seen it excelled. The disadvantages mentioned in adopting the Diesel engine are the need of frequent cylinder cleaning, possible rise in the price of oil fuel, danger in carrying fuel oil in bulk and the high cost of the installation. These are, of course, matters calling for careful consideration, but, with such quondam difficulties as reliability, continuous operation for long periods of time and maneuvering qualities unmentioned as serious objections to the service, the way looks bright indeed for the rapid adoption of the Diesel motor. 6,000 words.—*The United States Naval Institute Proceedings,* June.

Four-Cylinder, Four-Cycle, Diesel Engines.—An article describing engines built by Mr. Franco Tosi, of Legnano. The first-mentioned is a four-cylinder, four-cycle Diesel engine of 600 horsepower installed in the engineering section of the Turin Exhibition, where it contributes to the electrical supply. The cylinders are 21 inches diameter and 30.3-inch strake and the engine runs at 150 revolutions per minute. The second engine referred to is a four-cylinder, two-cycle marine Diesel engine of 500 horsepower when running at 170 revolutions. There are two independent scavenging pumps which are run at a less piston speed than that of the main engine. Connected to these and above them is a three-stage air compressor. Other auxiliary pumps are described in some detail. Cycle of operations necessary in starting, reversing and operating the engine are given in full, describing the action of the controlling mechanism. A third type of engine described is that fitted in an Italian torpedo boat. The propelling machinery consists of three sets of 6-cylinder, 2-cycle single acting Diesel engines of 800 shaft-horsepower each when running at their full speed of 330 revolutions. The engines are placed in separate compartments arranged longiudinally in the ship and are coupled to their propeller shafts by friction couplings. When running at cruising speeds of 14.5 knots or less, the center engine alone is used, the others being uncoupled and the propellers running free. In this condition, 240 shaft horsepower is developed at 170 revolutions per minute, the fuel oil consumption being .706 pounds per shaft horsepower hour, taking into account a 15 percent loss of power due to drag of the two side propellers. The radius of action at cruising speed with 15 tons of oil fuel on board is said to be 2,820 nautical miles. For running at full speed, 29 knots, the three engines develop 2,400 shaft horsepower with a fuel consumption of .496 pounds per shaft horsepower hour. Power can be increased to 3,000 shaft horsepower for half an hour, when the speed obtained is 31 knots. 4,200 words. Well illustrated by drawings and photographs.—*Engineering,* May 24.

The Langen & Wolf Diesel Engines.—The firm of Langen & Wolf, of Milan, builds Diesel engines for ships' auxiliaries in all sizes up to 600 horsepower, and up to the present its output amounts to 20,000 horsepower. The engines built are on the lines of the usual land type of engine, and are of the four-cycle, trunk piston type, with cylinder jackets cast with the A-frame supports. The air compressors are of the two-stage horizontal type, driven off the forward end of the crankshaft. The standard 400-horsepower engines have cylinders 440 millimeters diameter and 480 millimeters stroke, and give their power at a normal speed of 250 revolutions per minute, although they are capable of substantial overload for short periods. The pistons are made in two parts like the Tosi engines recently described and reviewed in these columns. The description of the engines goes into some detail. Illustrated. 1,800 words.—*The Engineer,* July 26.

The Japanese Battleship Kawachi.—The battleships *Kawachi* (now in commission) and *Settsu* (completing for sea) are the first all-big-gun ships of the single-caliber type for the Japanese navy. These ships have been built at Kure and Yokosuka, respectively, and have been building for somewhat over three years. The *Kawachi* is fitted with Curtis turbines on three shafts and the *Settsu* with Parsons turbines on four shafts, both ships having a designed horsepower of 25,500 and 20.5 knots speed. Mijabara boilers are used for both. Normal coal supply is 900 tons, with 2,500 tons for a maximum. The armament consists of twelve 12-inch, ten 6-inch and twelve 4.7-inch guns and five torpedo tubes. The main battery is placed in six turrets, arranged after the German *Helgoland* design. The armor consists of a waterline belt 12 inches thick amidships, tapering to 5 inches at the ends. Above this is a 9-inch belt, and above this a 6-inch belt reaching to the upper deck. Turrets are 9 inches thick. A 2½-inch protective deck supplements the side armor. The displacement is 20,750 tons. Illustrated with photographs and sketch plan. 3,000 words.—*Engineering,* July 26.

New Graving Dock, Belfast—Mechanical Plant and General Appliances.—By W. Redfern Kelley, engineer-in-chief to the Belfast Harbor Commissioners. The new graving dock at Belfast is the only one of its kind which will receive the *Olympic.* It is unusual not only for its great capacity but for its modern and complete equipment. The over-all dimensions are: Length, 901 feet; breadth, coping to coping, 128 feet; depth of water on keel blocks at mean high water, 32 feet 9 inches. The paper is not intended to deal with the general construction of the graving dock proper, but rather with those items of mechanical plant, such as the pumping installation, hydraulic system, boilers, capstans, caisson, culvert sluices, etc. The full capacity of the graving dock is about 21,000,000 gallons of water, and the duty of the pumping plant is to discharge this in 100 minutes. This is done by three centrifugal pumps, each having two suction pipes 42 inches diameter, driven by three cross-compound engines 22-38 by 20-inch stroke, running at 125 revolutions per minute and developing approximately 750 indicated horsepower on 160 pounds of steam. The boiler plant is composed of four Babcock & Wilcox watertube marine type boilers, each having 3,590 square feet of heating surface and 105 square feet of grate surface. Each boiler is fitted with superheater, delivering steam of 100 degrees superheat to the engines. The description continues to good length, and includes the other important

items of the mechanical plant. Well illustrated. 8,000 words. —*Transactions of the Institution of Mechanical Engineers,* July.

Notes Upon a Marine Engine.—By Mr. W. Veysey Lang. An unusual contribution upon a very ordinary subject. Mr. Lang writes for designers from the viewpoint of operators, suggesting and urging the adoption of what he considers best practice. This paper deals with the subject of main engines alone, boilers and auxiliaries being left for separate treatment. Some of the subjects discussed are size of engines, size of cylinders, clearances, cylinder liners, piston rings, shafting, thrusts, stern tubes, platforms, ladders, handrails, splash plates, air pumps, valves, rods and packing. Among other things he favors reduction of clearances, now commonly made unnecessarily large, the use of liners in all high and middle-pressure cylinders, the increase of boiler power rather than of engine size for a given job, a volute piston ring spring with the ring of softer metal than the liner, solid thrust carriage with heavy horseshoes bolted down on both sides, capable of slight adjustments at the ends, a thermometer in the thrust, interchangeability of parts and standardization of sizes wherever possible, and particularly with regard to rods and stems and their packing. There is included a list of proper spare gear which should be furnished, much of which, being now left to owners' discretion, is withheld. Some surprise and considerable discussion were aroused over the preference for the D-slide valve in all cylinders of a triple engine. In speaking of condensers, attention was called to the necessity of ample steam spaces between the rows of tubes, and an example was cited where the vacuum was increased from 23 inches to 25 and 26 inches by taking out tubes, fitting of steam baffles, and better arrangement of flow of circulating water. 18,500 words.—*Transactions Institute of Marine Engineers,* July.

Dahl Oil-Burning System.—The advantages of mechanical atomizing in oil burners for marine service are great enough to insure their early development. The Dahl system of mechanical atomizers, patents of which are controlled by the Union Iron Works, of San Francisco, has been installed on a large number of ships and has proven very satisfactory, even with the difficulties encountered in burning the heavier oils. The main advantage of mechanical atomizer over the steam jet is the saving in fresh water required; over the air jet, the saving of an air compressor which must be positive in action, and the necessary piping. The Dahl burners are simple, have few parts, and clogging of the tips is guarded against by three separate strainers at different points in the system. These burners have been run thirty-six hours under the most adverse conditions without becoming clogged or requiring cleaning. Very few changes are necessary in boilers having Howden draft. The essentials of the system are a pump, heater and burner, although a reserve pump and heater are always fitted. There are no moving parts to the system except the pump, and its operation is without noise. The temperature recommended for fuel is from 180 to 200 degrees, and the pressure should be about 60 pounds per square inch. Complete instructions for operating are included, together with a table of ships fitted with Dahl burners. Fully illustrated. 1,900 words.—*Marine Review,* August.

British Steamship Centenary—The Comet and Her Creators. —That the shipbuilding industry is only a century old would scarcely seem possible viewed in the light of the present achievements. That such is the case, however, is shown by the celebration recently held on the River Clyde, where relics of the first steamboats were shown and a grand processional display of shipping was held, which was taken part in by warships of several types as well as representatives of the merchant fleets. The article herein reviewed does not refer to the centenary celebration but to the early history of the industry itself, endeavoring, as is stated, to avoid traversing the oft-trodden ground of a sequent and detailed story of Bell and the *Comet,* and to emphasize less known and perhaps debatable points of the subject. Following out this purpose some very interesting facts regarding the building of the *Comet* and other vessels immediately following this pioneer are given. Not only is the mere sequence of events shown but the attitude of the builders, who believed, even then, that at some time the steamboat would be known on all waters. The article is well illustrated with photographs of the *Comet,* her engines and the builders, and a drawing of the lines of the vessel. 4,800 words.—*The Marine Engineer and Naval Architect,* August.

Wire Ropes for Lifting Appliances and Some Conditions that Affect Their Durability.—By Daniel Adamson. The question of durability of parts of mechanical structures is a subject apparently not given the attention by the authorities that their strength receives, for while one generally has the choice of several formulæ for the latter consideration, little of definite knowledge is available for the former subject. In the subject of wire ropes especially does this author find such a lack. This contribution to the Institution of Mechanical Engineers is the report of a study of the subject made to put into definite shape all available information on the subject. A number of sources are quoted, but the most satisfactory seems to be a set of experiments made to determine the best form of cable to be used in the building of the Forth Bridge by Mr. A. S. Biggart in 1890. From the data of these tests and conclusions from others, some quite practicable results are obtained. Elements of the subject considered are size of pulley, number of bends and reverses, size of wires in cable, and whether cable is oiled. Tables are drawn up and curves drawn showing relative life of rope with each of these elements varying. That oiling the cable increases its life very much, that reverses are detrimental to endurance, and even that several bends are not conducive to lasting qualities are some of the conclusions reached. Illustrated with sketches of various arrangements of ropes in lifting appliances. 3,800 words.—*Transactions of the Institution of Mechanical Engineers,* July.

Ten-Horsepower "Monobloc" Marine Oil Engine.—A detailed description of a small marine oil engine made by Messrs. Boulton & Paul, Norwich, with all four cylinders cast in one piece. In size 3 inches diameter and having 5-inch stroke, they have the exhaust pipe and water-jacket around it also cast *en bloc.* To insure getting the cores cleanly away, a long inspection door is provided in the water-jacket of the exhaust pipe. Water-jackets around the cylinders are large, to insure ample cooling. The description is carried to some detail. Illustrated by drawings and photograph. 480 words.—*Engineering,* August 16.

Shipbuilding in Russia.—In order to promote the national shipbuilding industry the Russian Government has prepared a scheme for developing the merchant marine of Russia simultaneously with the establishment of a new navy in that country. It is proposed to grant a bounty of from 65 to 105 roubles per ton on all ocean-going ships built in Russian yards, while a further payment of one rouble and a half per pood is to be made on parts of machinery constructed for Russian-built vessels. It is also intended to encourage the investment of native capital in national shipbuilding undertakings by extending the legal proportion of the loan capital to the ordinary share capital in the sense that the loan capital without any regard to the share capital may be increased to an unlimited extent. It is already possible for the shipbuilders to obtain loans from the State at a low rate of interest of 3.6 percent for a period of twenty years, and to the extent of 40 percent of the cost of constructing the hulls of vessels and 30 percent of the cost of the machinery, and this practice is to be continued in future. The scheme also provides for the admission free

of duty of foreign-built ships which may be acquired by Russian shipping companies. 840 words.—*The Engineer*, September 27.

Suction Between Vessels.—By Prof. A. H. Gibson and J. Hannay Thompson. The experiments described in this paper were carried out in the Firth of Tay to obtain the magnitude and range of action of the forces involved in case of suction or inter-action between passing vessels. Two screw-propelled vessels were used. One, the steam yacht *Princess Louise*, was 88.5 feet in length, 13 feet beam, 5.66 feet mean draft, displacing approximately 96 tons. The second was a motor-driven launch, 29.33 feet long and 6.75 feet beam. Each was driven by a single screw. The experiments were divided into two distinct sets. In the first the vessels were maneuvered until on sensibly parallel courses heading for the same distant object, their lateral distances apart and speeds being varied in different experiments. The relative positions of the two boats were fixed by observations taken every fifteen seconds during each run. Also, at the same intervals readings were taken from a series of pressure boxes fixed to the hull of the smaller boat from which the turning moments and lateral forces acting on the hull of the boat were computed. The second series of experiments was carried out to measure the helm angle required to maintain the course of the smaller when in the vicinity of the larger vessel. The general conclusions from the experiments were as follows: The greater the difference between the speeds of the vessels the smaller is the risk of collision, since such a difference reduces the time during which the mutual forces are operative, such an effect being much more marked when the smaller vessel is the faster, but if the larger vessel is the faster, and particularly if her speed is accelerated while passing the smaller, the attractive forces are increased to an extent which partially, and in some cases entirely, counterbalances the effect of a reduction in the time during which the vessels are in dangerous proximity. It follows that any attempt of the larger vessel to draw ahead of the smaller by increasing her speed greatly increases the risk of collision. On the whole, the results of the trials show that under unfavorable circumstances inter-action is a very real danger to navigation even in deep and open waters. With vessels of the relative sizes adopted for the experiments, if the possibility of inter-action is realized from the very first, and if all initial swerve is prevented by an early application of the helm, there would appear to be little danger even at lateral distances so small as one-half the length of the smaller vessel, but if this possibility is not realized and such a swerve has once been initiated, a much greater helm angle is necessary to control the vessel, and, failing immediate control, collision occurs within a comparatively few seconds even from astonishingly great distances. The importance of this fact is more readily grasped when it is realized that with a vessel of, say, 300 feet in length passing a vessel of, say, 900 feet in length, the forces of inter-action have to be reckoned with even when the vessels are 1,000 feet apart laterally, which would be ordinarily considered to be giving the larger vessel a very wide and safe berth.—*Transactions of the British Association*, September, 1912.

Recent Progress in Diesel Engines.—A table is given in which are included thirty-two motor vessels now under construction or under contract, all of which are of large size, the power in none being less than 400 horsepower, and, except in four, it is over 1,000 horsepower. Twenty-six of these vessels have twin screws, although all of those equipped with Carels engines are single-screw boats. Eighteen of the vessels have four-cycle engines and fourteen are fitted with two-cycle engines. Of the double-acting engines apparently only two are on order except for naval purposes. The only marked deviation from ordinary design is found in the Junkers engine, which will soon be given a fair trial. 2,700 words.—*The Motor Ship and Motor Boat*, September 26.

The Launch of H. M. S. Audacious.—The super-dreadnought *Audacious*, a ship of 23,000 tons, 596 feet long over all, 555 feet long between perpendiculars with a beam of 89 feet and a draft of 27 feet 6 inches, was recently launched from the Birkenhead yard of Messrs. Cammell, Laird & Company, Ltd. The ship will be fitted with Parsons turbines to develop 31,000 shaft-horsepower for a speed of 21 knots. She is to be fitted with Yarrow boilers. Her main armament consists of five pairs of 13.5-inch guns, and she will have twenty smaller weapons and three torpedo tubes. Her broadside armor will consist of a belt 12 inches thick amidships, reduced by steps to 4 inches at the bow and stern. The heavy guns will be protected by 11-inch armor. 550 words.—*Engineering*, September 20.

The Price of Diesel Engines.—On acocunt of the fact that practically every marine Diesel engine built is something quite new, and that the engine has been produced only at the expense of a vast amount of experimental work, it is to be expected that the cost of the engine at present should be higher than might even be expected from the amount of high-class workmanship required in the production of such a complicated engine. The rapid progress of the two-cycle type of engine is noticeable, and it is expected that this type will be materially cheaper than the four-cycle engine. In the case of engines for naval vessels, the high cost is not an insurmountable barrier. On the whole it seems to be a conservative view to anticipate that within four or five years the difference in the cost of steamships and motor vessels will be practically negligible, the hull costing a little less in the case of a motor ship and the machinery slightly more. 1,200 words.—*The Motor Ship and Motor Boat*, September 19.

Marine Propulsion by Electric Transmission.—By Henry A. Mavor. This paper describes all the notable installations of electrical drive for ship propulsion, including those supplied by the General Electric Company for the United States naval collier *Jupiter* and the Chicago fireboat *Graeme Stewart*, which have already been fully described in the technical press. The last installation is that on an oil-engined tank barge, which is now being built in England for Canadian service. The present arrangement of this ship gives an increase of about 250 tons in the carrying capacity as compared with a steam equipment. The vessel is 256 feet long over all, 250 feet long between perpendiculars, 42 feet 6 inches breadth extreme, 19 feet depth, molded, designed for a speed of 9 knots. On a 14-foot mean draft in fresh water it is estimated that the vessel will carry about 2,400 tons deadweight of cargo, fuel, fresh water and stores. Two steam boilers are provided for working the deck equipment, steering gear and electric light and for the supply of heat for the living quarters. The main machinery equipment comprises two units, each consisting of an oil engine, dynamo and a winding on the propeller motor. The engines are of the high-speed type, which has been developed by Messrs. Mirrless, Birkerton & Day, with cylinders 12 inches diameter, 13½ inches stroke; revolutions per minute, 400. The electric equipment consists of two three-phase generators, giving about 235 kilowatt-amperes at 500 volts alternating. The generators have six and eight poles, respectively, giving frequences of 20 and 26.6 per second. Connected to the shaft of each generator is an exciter, which in normal working gives about 30 amperes at 100 volts, but is capable of a considerable overload. A single three-phase motor developing 500 shaft-horsepower is coupled direct to the propeller shaft. The machinery is controlled by a simple gear, which can be operated from either the bridge or the engine room as desired. Illustrated. 4,000 words.—*Transactions of the British Association*, September, 1912.

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In devoting our present issue to the subject of shallow draft boats we are adhering to a custom inaugurated two years ago, which, on account of the interest aroused in modern transportation on inland waterways, seems worthy of further consideration. To the old-time river boatman who has witnessed the decline of steamboating on the great Western rivers of the United States from its flourishing condition in pioneer days to its present lethargy, and to the railway enthusiast who has been so eminently successful in diverting traffic from the rivers, it no doubt seems visionary to look for success in the rehabilitation of inland waterway commerce. An interesting article on another page of this issue, reprinted from one of the leading railway journals, sets forth conclusively the principal reasons for this decline, and those who are conversant with the history of steamboating on the Mississippi will recognize the truth of these statements. A more scientific study of certain phases of the subject can be found in a series of articles on the "Lakes-to-the-Gulf Deep Waterway," published in recent issues of the *Journal of Political Economy;* but, notwithstanding the discouraging outlook for river transportation thus brought forth, it must be admitted that to-day the Western rivers offer the same facilities for navigation that were available in former times, and, in some respects, vastly improved facilities. On the other hand, the type of equipment has not kept pace with the rapid development of improvements in shipbuilding and marine engineering that are manifest in ocean traffic, nor has the problem of developing adequate terminals for river conditions been thoroughly solved. It is in these directions that opportunities should be sought for restoring inland waterway commerce to a position of economic usefulness.

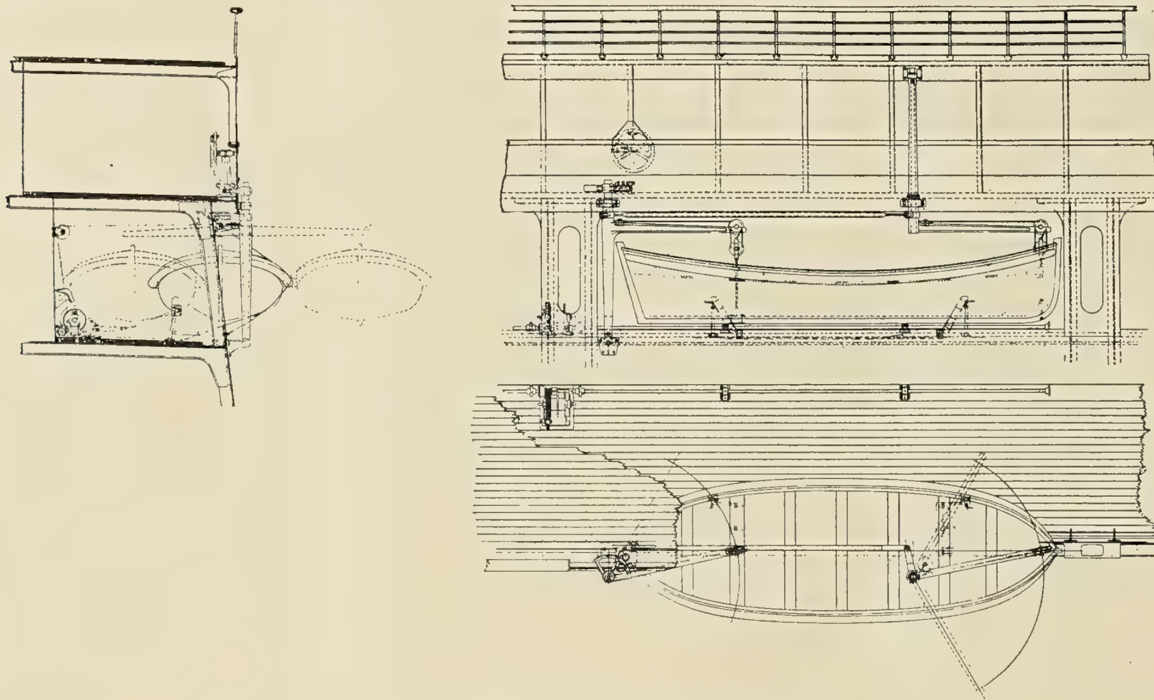
According to the returns compiled by Lloyd's Register of Shipping, which, excluding warships, take into account only those vessels actually under construction, there were building in the United Kingdom at the close of the quarter ended September 30, 1912, five hundred and five vessels, of 1,846,829 tons gross. This is about 73,000 tons more than was in hand at the end of the last quarter, and exceeds by 400,000 the tonnage building in September a year ago. These figures are the highest ever recorded in Lloyd's returns, and give a good indication of the remarkable expansion of the shipbuilding industry in the United Kingdom during recent years. Until 1911 the amount of shipbuilding under construction at any one time had barely exceeded 1,400,000 gross tons, although this figure had been reached in three previous years—first in 1898, again in 1901, and finally in 1906. On each of these occasions, however, the volume of tonnage rapidly diminished after this figure had been reached. On the other hand, in 1911 the volume of tonnage under construction, after reaching this figure, continued to increase at an almost uniform rate until the present remarkable figures were attained, establishing a period of prosperity in the British shipbuilding industry never before realized; and with the prospect of continued activity in this direction, unless serious labor troubles or other disturbances arise, the English shipbuilders can look forward with confidence to the coming year.

In the United States the condition of the shipbuilding industry is also encouraging, as we have noted in previous issues. For the quarter ended September 30, 1912, the Bureau of Navigation reported 485 sailing, steam and unrigged vessels of 80,281 gross tons built and officially numbered, while during the corresponding quarter last year only 462 vessels, aggregating 76,048 gross tons, were built. Besides the increase in tonnage there is another marked change in these reports. Last year 50 percent of the shipbuilding was on the Great Lakes, while less than 40 percent was on the Atlantic coast. This year, however, 60 percent of the shipbuilding was on the Atlantic coast, while less than 22 percent was on the Great Lakes. Thus, with the coast yards engaged to normal capacity and with reasonable assurance that the Lake yards will shortly recover from a temporary depression, there is every reason to anticipate a successful year in the American shipyards.

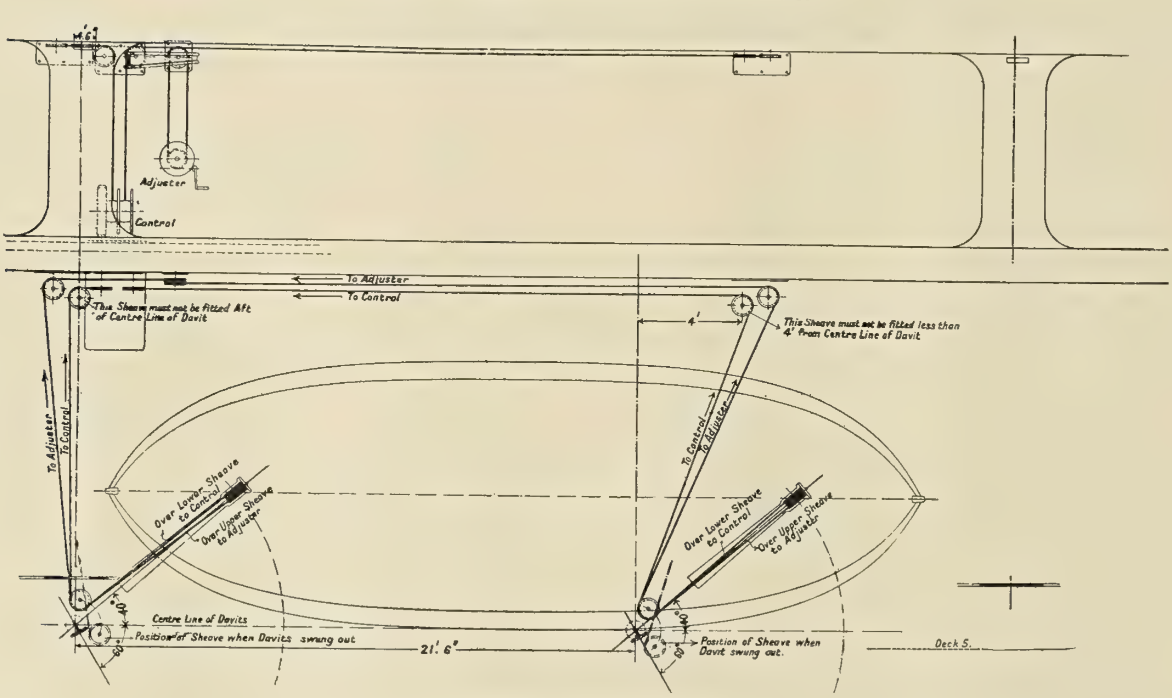
Improved Engineering Specialties for the Marine Field

Welin Boat Davits for the Imperator

In a paper read before the British Association at Dundee in September, Axel Welin, the inventor of the quadrant davit, described the recent improvements in lifeboats and their manipulation on board ship. His conclusions as to the best type of life-saving gear are that a properly constructed lifeboat, placed under efficient launching gear, is the best and safest appliance obtainable, and that a high degree of reliability is in these matters of far greater importance than a possible saving of a few seconds. Attention is called to a method of grouping lifeboats which offers several advantages. Along the extreme edge of the deck is placed an ordinary lifeboat (with or without a motor), directly attached to the lowering tackle of a double quadrant davit, and immediately inboard, stowed one above the other, are two "decked" lifeboats of the type (see page 252, June issue) invented by Capt. A. P. Lundin, president of the Welin Marine Equipment Company, Long Island City, N. Y. In this arrangement three boats are handled by a single pair of davits, the only difficulty, the fouling of the tackle, being overcome by the use of a non-toppling block, which prevents this. The radical departure brought forth in this paper, however, is a new type



GENERAL ARRANGEMENT OF WELIN LOWER-DECK DAVIT

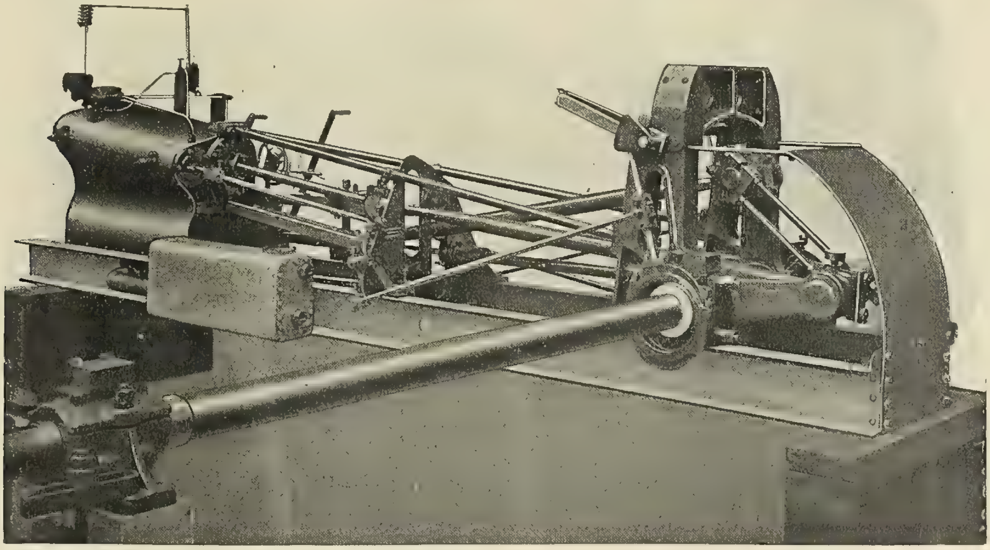


CONTROL OF LOWER-DECK DAVIT

of the Welin davit adapted for the handling of lifeboats placed between the lower and upper promenade decks, thus enabling the carrying on large ships of a greater number of lifeboats, and in such a manner that the boats are launched from a less height than would be necessary if all the boats were stowed on the boat deck. As an example of this arrangement the installation of Welin davits on the new Hamburg-American steamship *Imperator* is described. A model of the arrangement of lifeboats on the *Imperator* was also exhibited by Mr. Welin recently on the floor of the Maritime Exchange, New York. On the *Imperator* the boat deck lies some 70 feet above the waterline. Placing the boats on the lower decks permits launching of the boats in from 40 to 50 seconds, and gives the boats a far better chance of reaching the water safely than if launched from the lofty boat deck. A special adjusting gear permits lowering the boats at any desired angle, as may be required by the trim of the vessel itself. The hoisting is done by means of electrically-driven fore-and-aft transmission shafts, provided with friction drives, each boat being handled quite independently of the others. The largest lifeboats are capable of accommodating seventy-six people, and weigh, fully loaded, approximately 8 tons each. The principal mechanical feature of the arrangement is that one, at least, of the two davits is supported above the boat instead of socketing it at a point below, as is usual. The general arrangement can be seen from the illustrations. The two davits are connected by a coupling rod attached to short cranks on the davits proper, so that the arms stand at every point parallel to one another. The boat travels parallel with its own axis, and the tackles always remain in a vertical position.

Side Paddle Wheel Engines for Shallow Draft Steamers

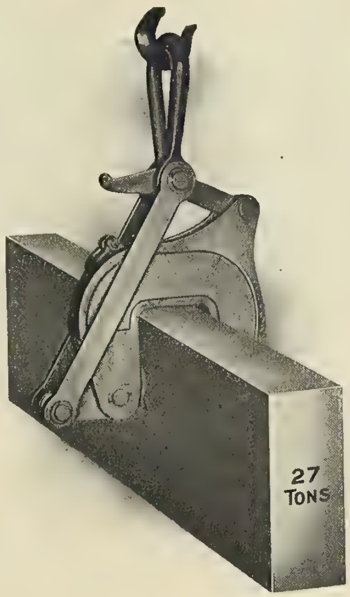
The illustration shows the arrangement of a light, compact engine which is manufactured by W. Sisson & Company,



Gloucester, for use on side paddle-wheel shallow draft steamers. The particular engine illustrated is a set of compound, non-condensing engines, 8½ inches and 13½ inches diameter by 36 inches stroke, using steam at 150 pounds gage pressure and operating at 45 revolutions per minute. The engines are erected on two longitudinal deep angles, channels or I-joists of rolled section for bolting down to the hull of the vessel, thus procuring a rigid structure.

Positive Patent Lifting Clamp

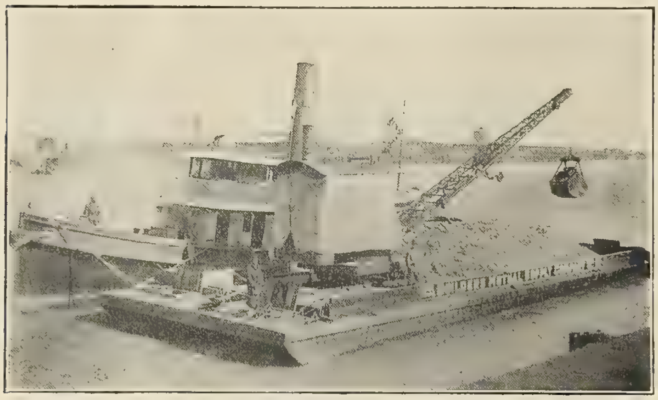
A lifting clamp made both for lifting and for hauling in any capacities ranging from ½ to 50 tons; for handling plates, beams and structural shapes for use in steel works, rolling mills, boiler and tank shops, iron and brass foundry annealing



furnaces; for railroad and steamship companies in loading and discharging, and, in fact, for all purposes where a positive and reliable clamp is required, avoiding the danger of swings, ropes, etc., besides effecting a large saving in time and labor, has been placed on the market in England by the Weldless Chains, Ltd., Coatbridge, Gartsherrie, and in America by William E. Volz, 126 Liberty street, New York. The clamp is made in various sizes, the one illustrated being supplied for lifting armor plates 9 inches thick and weighing 27 tons. The clamps are made from mild steel castings and forgings with a tempered steel serrated piece dovetailed to the side of the gap frame. The gripping cam is also tempered on the working face. It is claimed that the grip is instantaneous and positive, and the heavier the load the firmer the hold.

A Crane for Flat River Boats

The Browning Engineering Company, Cleveland, Ohio, has adapted some of its well-known locomotive type cranes to

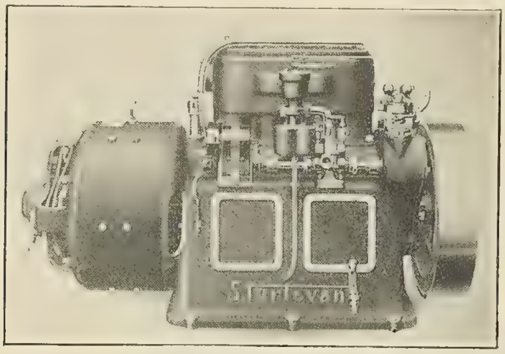


special uses for loading and unloading flat river boats. The illustration shows a typical installation of such a crane, which is placed directly on the boat and used not only for dredging but also for unloading material from the boat.

Sturtevant Gasolene (Petrol) Electric Generating Sets for Marine Use

The law which has recently gone into effect requiring that every vessel shall be equipped with an auxiliary generating set, situated upon the deck of the ship and supplying electric current for the operation of wireless apparatus has created a sudden demand for such a generating set and a demand that must be met immediately. The appearance of the new Sturtevant gasolene (petrol) electric generating set manufactured by the B. F. Structural Company, Hyde Park, Mass., is, therefore, very opportune, especially as it is well adapted to this line of work.

These sets consist of Sturtevant gasolene (petrol) engines direct connected to Sturtevant electric generators. The two are mounted upon the same cast-iron base and are so well



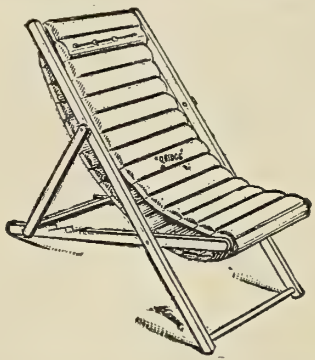
balanced that it is simply necessary to secure the sets to the deck of the ship to prevent shifting in high seas. They are always ready for duty as an auxiliary or for continuous duty as the prime mover. The simplicity of construction and dependability of operation insure proper results whenever they are called upon for service. This reliability of service is a characteristic Sturtevant quality found especially in these, and the steam engine generating sets which the B. F. Sturtevant Company have manufactured for the United States Navy for so many years. The same type of generator is used in these gasolene (petrol) sets as is used with Sturtevant steam-driven combinations.

Besides the use as wireless outfit apparatus, these sets will give economical and satisfactory results as lighting plants for ships of all kinds, either as auxiliary or main lighting plants. They are independent of accident in the engine room if placed on the deck, and insure illumination under all circumstances. No storage battery is necessary with these sets, as a particularly sensitive governor controls the speed so closely that wide variations of load cause no fluctuation of the voltage or flickering of the light. The lubrication is forced and automatic.

The engine is of the vertical multicylinder automobile type, operating on the four-stroke cycle principle and water cooled. Four and six cylinder combinations are used, according to size, the present sizes being 5, 10 and 15 kilowatts.

Life-Saving Deck Chair

Leoline Edwards, 81 St. Margaret's Road, Twickenham, has placed on the market a folding steamer chair which is capable of supporting the weight of two persons in the water. The frame of the chair is firmly built, and in place of the ordinary single canvas there is a backing of double green



waterproof canvas laced at the ends. Across this canvas are sewn divisions equally all around, and these divisions are separately filled either with granulated cork, kapok, koma, reindeer hair, or other buoyant material as desired, and sewn securely in, giving a most restful, soft, springy seat. The whole of the backing of this chair can be pulled around like a roller towel, thus presenting a dry seat even in wet weather.

Technical Publications

Beeson's Marine Directory of the Northwestern Lakes. By Harvey C. Beeson. Size, 6¾ by 9½ inches. Pages, 270. Numerous illustrations. Chicago, 1912: Harvey C. Beeson. Price, $5.00.

As this is the twenty-sixth annual number of this directory it needs no introduction to marine people. Its contents this year are even more varied than heretofore. The numerous tables of American and Canadian steam vessels on the Lakes, gas-engined vessels, records of engines and boilers, officers of Lake marine associations, etc., have all been brought up to date, and the tables are supplemented by a number of interesting articles on important marine happenings during the past year.

Centrifugal Pumping Machinery. By Carl George de Laval. Size, 6 by 9¼ inches. Pages, 184. Illustrations, 159. New York, 1912: The McGraw-Hill Book Company. Price, $3.00 net.

The general subject of centrifugal pumping machinery has been treated briefly in many standard textbooks on hydraulic machinery, but few of these treatises give sufficient information to aid a designer. This book has, therefore, been prepared with the idea of supplying accurate and definite information which can be used in actual design. The author has had an extensive experience in this line of work, and the data which he gives are based upon the results obtained with such installations as have been turned out by the company with which he is connected. The book is, therefore, a record of facts and it can be considered as authoritative. The book is by no means elementary, although the underlying principles are given, so that no mistake could be made in their application.

The Principles of Heating. By William G. Snow. Size, 5¾ by 9 inches. Pages, 224. Illustrations, 60. New York, 1912: David Williams Company. Price, $2.00.

This is a practical and comprehensive treatise on applied theory in heating. The contents of the book are largely made up of a collection of articles by the author which have been published in *The Metal Worker, Plumber and Steam Fitter.* These contributions have been supplemented by reprints of articles relating to heating prepared by other writers. The opening chapters deal with the heating power of fuels, boilers and combination heaters; gas, oil and electricity versus coal; heat driven off by direct radiators and coils; the loss of heat by transmission; heating equivalents, etc., following which are chapters on capacities of piping for hot-water heating, the flow of steam in pipes, and then the different systems of heating are taken up, including steam, hot water, central heating plants and mill heating. There are a great number of charts and tables in the book, but these are interspersed in the text as they apply to the subject under immediate discussion.

The Rule of the Road at Sea and Precautionary Aids to Mariners. By Daniel H. Hayne. Second edition. Size, 5½ by 8 inches. Pages, 165. Baltimore, Md., 1912: The Co-operative Publishing Company. Price, $3.25

This manual was issued in 1897 for private distribution, but on account of the interest evoked by its publication, the book has been revised, enlarged and issued in its present form. The author is a member of the Baltimore Bar, and for this reason is familiar with the Admiralty law and important cases which have been settled by Admiralty courts, thus enabling him to bring before the reader in condensed form a great mass of useful information as to the conduct of navigation at sea. The purpose of the manual is to emphasize the necessity of closer co-operation between navigators by direct address to the personal side of the problem, and thus secure a more prompt and uniform compliance with the rules and regulations designed to prevent marine collisions. Heretofore it has been quite difficult for a navigator to keep abreast of prevailing decisions of the courts, as some of the rules are silent on important points which must be fully understood to effectually apply them. So, too, it has been observed that there is no systematic method of bringing to the attention of each individual on shipboard the precautionary measures required in his particular line of duty. The use of this manual, therefore, gives the responsible person an opportunity to familiarize himself with his duties in the matter of navigation and bring him to recognize his responsibilities. It is of particular value to motor or power boat owners and operators and yachtsmen, who largely through ignorance are daily taking unnecessary risks in navigating their vessels. Part I. of the manual refers briefly to practical precautions relating to the rules of the road and to certain well-considered court-made rules defining good seamanship, which are applied as rigidly as the navigation rules. Part II. presents some of the more practical elements in ship conduct and discipline and precautions in handling the vessel and its equipment, to which prudent navigators have attached much importance and to which they owe their immunity from accident.

The Romance of Submarine Engineering. By Thomas W. Corbin. Pages, 316. 38 Great Russell street, London, W. C. Seeley Service & Company, Ltd.

A fascinating subject is covered by Mr. Thomas Corbin in his "Romance of Submarine Engineering." This work is the latest addition to the admirable series of the library of romance published by Seeley Service & Company, Ltd. Some fifty-four diagrams and photographs are included, which add considerably to the interest of the volume. We remember two previous volumes by Mr. Corbin upon engineering and mechanical invention, written in non-technical language, and the present volume is not at all behind these two extremely well-written books. He has aimed at giving in popular language descriptions of how submarine boats are constructed, the recovery of sunken treasure, the building of breakwaters and docks, and many other feats of engineering beneath the surface of the water. The volume gives in clear language an account of the men, their tools and the work associated with engineering under water. The subject is one that lends itself to being dealt with in a fascinating manner, and Mr. Corbin has written a volume each chapter of which is full of information. The language employed is simple and the style excellent, and the subject is treated with enthusiasm.

Heroes of Science. By Charles R. Gibson. Pages, 344. 38 Great Russell street, London, W. C. Seeley Service & Company, Ltd. Price, 5/–.

An interesting addition has been made to the "Heroes of the World" series of books published by Seeley Service & Company, Ltd.—a series which has secured a well-merited reputation. The new volume, which is excellently illustrated, is devoted to heroes of science, and the author, Mr. C. R. Gibson, F. R. S. E., has given a description of the lives of some of the most outstanding men of science in an easy and readable form. Mr. Gibson has already achieved considerable success in his several other works on scientific subjects written from a popular standpoint, and the new volume enhances that reputation, as it shows all the merits of its predecessors. Some fifty-three men of science are mentioned in the work, and they are introduced in chronological order, covering a period from 1214 to 1912, or Roger Bacon to Lord Lister. The author states that he has gone to considerable trouble to authenticate all the information he gives as far as possible, and has not sacrificed accuracy for the sake of sensation or effect. No subject is more fascinating than science, and no literature more readable than biography. We heartily welcome, therefore, this work, which is an admirable combination of the two.

Kings' Cutters and Smugglers—1700-1858. By E. Keble Chatterton. 8½ by 5½ inches. 425 pages. London, 1912: George Allen & Company, Ltd., 44-45 Rathbone Place. Price, 7s. 6d. net.

The halo of romance which surrounds stories of smugglers and kings' revenue cutters never fades even in our later and more prosaic days. We therefore welcome the excellent volume which Mr. E. Keble Chatterton has written dealing with the romantic history of kings' cutters and smugglers during the century and a half extending from 1700-1858. As we have pointed out before, Mr. Chatterton, who is a prolific writer, knows his subject thoroughly, has a capital style, and is a keen yachtsman. The present volume, he tells us, represents an effort to look at the exploits of old-time smugglers as they actually were, and not as a novelist likes to think they might have occurred. The book is none the less interesting for being written from this standpoint. The value of the book is increased by reason of the appendices, in which Mr. Chatterton has included some interesting historical data, the collection of which has, we learn, involved a great deal of labor. Full particulars are included regarding the dimensions and details of a revenue cutter's construction, her tonnage, guns, etc., the number of her crew, and the names and dates of the fleets of cutters employed. The illustrations, which number thirty-three, are all excellent and include some taken from old prints.

Personal

WILLIAM T. DONNELLY, consulting engineer, New York City, has been appointed engineer of the State Commission on Steamship Terminals at New London, Conn.

WILLIAM GARDNER, naval architect, has formed a co-partnership with Mr. Frederick M. Hoyt and Mr. Phillip Leventhal, under the firm name of William Gardner & Company, naval architects, engineers and yacht brokers, with offices at No. 1 Broadway, New York.

Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

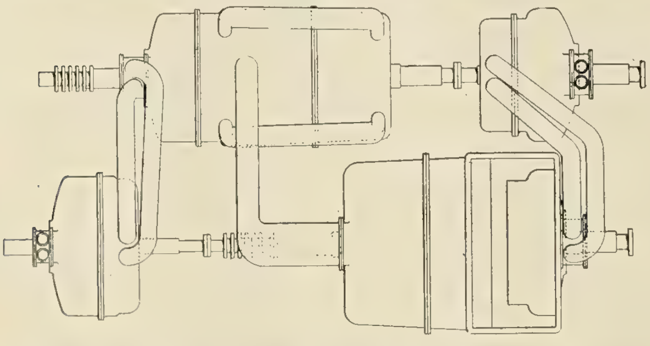
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,027,720. MARINE RAILWAY. ROBERT O. GALLINGER, OF SEATTLE, WASHINGTON.

Claim 2.—The combination with railway tracks at opposite sides of a body of water, and a railway track submerged in said body of water, of a wheeled carriage mounted for travel upon the last-named track, a railway track upon said carriage, power means for effecting the travel of the same between the terminals of the first-named tracks, means for automatically securing the carriage at the ends of its travel, and means operated from a car for disengaging the carriage securing means. Four claims.

1,027,698. MARINE STEAM TURBINE. CHARLES G. CURTIS, OF NEW YORK, N. Y.

Claim 2.—In a marine steam turbine, the combination with two propeller shafts, of high and low pressure turbine elements on one shaft,



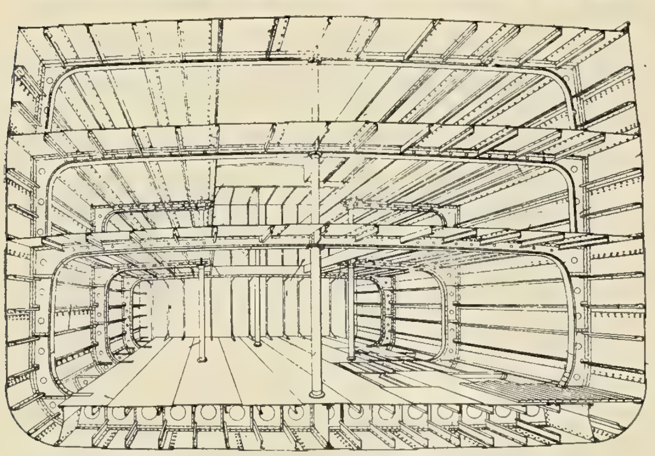
an intermediate pressure turbine element on the other shaft, the latter having reversed drum stages. Twelve claims.

1,025,930. VESSEL-RAISING DEVICE. BYRON J. SPENCER, OF FORT STEVENS, OREGON.

Claim.—A sling for raising ships and the like comprising cables adapted to be disposed against the frames of a ship, U-shaped anchoring members having their ends extended through said frames and impinging said cables thereagainst, rings secured to the free ends of said cables, and horizontally arranged cables secured to said rings. One claim.

1,029,546. CONSTRUCTION OF FLOATING VESSELS. JOSEPH WILLIAM ISHERWOOD, OF MIDDLESBROUGH, ENGLAND.

Claim 1.—A vessel in its main body portion provided with consecu-



tive transverse frames individually a plurality of times stronger and spaced a plurality of times farther apart than has heretofore been customary in the same class of vessel, said frames extending to the shell or deck plating of the vessel, said vessel being also provided in said portion thereof with longitudinal frames which, as compared with the transverse frames, are individually weak and very closely spaced, and which also extend to the shell or deck plating of the vessel. Twelve claims.

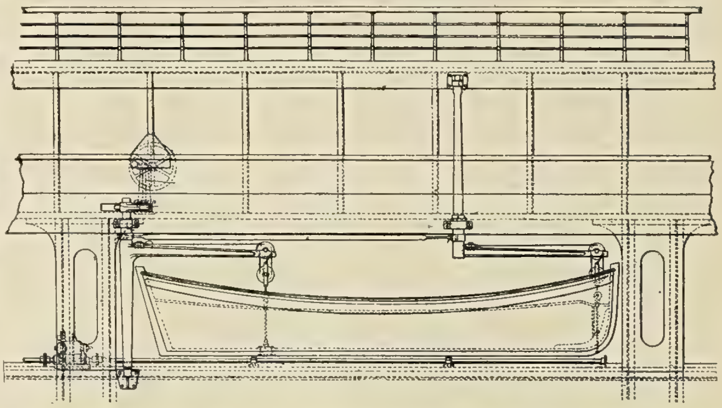
1,033,810. DIVING-GEAR FOR TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, NEW YORK, ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF WEST VIRGINIA.

Claim 1.—In an automobile torpedo the combination with a depth steering mechanism comprising a pendulum, a hydrostat, and a steering engine controlled by either of them, of means for preventing the transmission to said engine of the rearward or lagging movement of the pendulum during the acceleration of the torpedo at launching, such means adapted to leave the steering engine under control of the hydrostat. Eight claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

14,511. BOAT-LOWERING APPARATUS. A. WELIN, LONDON.

This apparatus is constructed so that the life-boat may be carried on any of the lower decks. The arrangement allows the boat to cross the axis of one davit and to swing inboard to such a position that none of



it projects beyond the side. This end is attained by supporting one davit from above. The boat is thus always parallel to the ship's side and the falls hang vertically.

16,305. SIGNALING APPARATUS FOR INDICATING THE APPEARANCE AND DISAPPEARANCE OF WATER IN SHIPS. N. PODGOURSKY, ST. PETERSBURG.

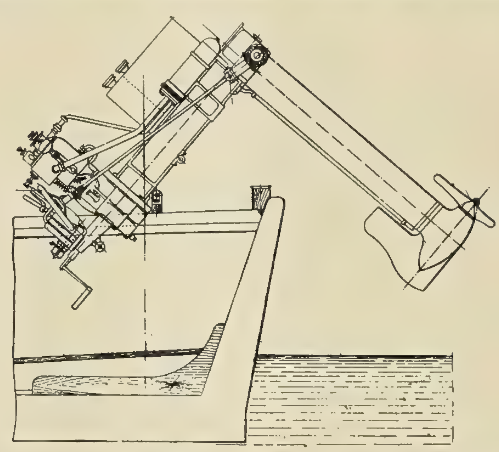
By this invention a float is mounted on the spindle of a commutator in a hermetically closed casing, or to a like casing which rotates and contains a pendulum contact for closing or opening an eletric circuit when the casing rotates, the commutator being switched into the general circuit or into the circuit of a separate battery, so that when the float rises owing to the inflow of water and the spindle is turned the circuit is automatically closed, and operates a signal.

22,684. APPARATUS FOR STEERING TORPEDOES. L. OCENASEK, Prague.

By this invention the movements of the torpedo after leaving the dispatch station are controlled by means of a beam of light projected from the station. The torpedo proper is carried by a vessel having steering and disengaging gear. The control is effected by means of corresponding turning forks at the station and on the vessel. The vibrations of a station fork are used, through an electro-magnet, to vary the current flow in the light circuit so that the intensity of the beam is varied intermittently. The beam is received by a selenium cell on the vessel placed in an electric circuit thereof, and whose varying intensity causes the corresponding fork to vibrate and mechanically close the circuit of a motor for operating, say, the disengaging screw which relieves the torpedo.

28,201. UNDER INTERNATIONAL CONVENTION. DETACHABLE PROPELLING INSTALLATIONS FOR SHIPS AND BOATS. SOCIETE G. DUCASSOU AND COMPAGNIE, PARIS.

This installation is pivoted near the stern of a boat, and has a dipper arm carrying the screw and its block, the latter being integral with a



rudder blade. This construction allows of steering when the screw is not working. The block can be turned by the steering gear through the entire circle, whilst the whole installation may be oscillated about the deck pivots to bring the screw up for inspection, for avoiding weeds, etc.

28,197. APPARATUS FOR SEIZING SUBMERGED BODIES, ETC. A. LAUMET, PARIS.

Hooks or arms are pivoted to a platform and are kept open by a second platform suspended from the lowering rope and engaging pins on the hooks. The device is lowered until a feeler rests upon the object to be raised, and so allows the platform to descend and release the arms, which then turn downwars and clasp the object, which may then be raised by means of the rope. The arms may be prevented from opening by a ring lowered around them by means of a wire sling and auxiliary rope. Modifications are descrbed.

International Marine Engineering

DECEMBER, 1912

The First Italian Dreadnought Dante Alighieri

BY DAGNINO ATTILIO

The *Dante Alighieri* was built in the Royal Navy Yard at Castellamare di Stabia. She is one of six big-gun battleships recently authorized by the Italian Parliament. Her machinery was furnished by Messrs. Gio. Ansaldo & Company, from the Sampierdarena and Cornegliano Works. The vessel was designed for a speed of 22.50 knots on a displacement of 18,200 tons, with the main turbines developing 26,000 shaft horsepower, a performance which was easily attained, as shown by the trial data given later.

Notwithstanding the very powerful armament provided, the armored protection is most effective, particularly against torpedo attack. The main broadside armor is of special quality steel 10 inches in thickness, extending considerably below the water line. There is an armored deck at the water line level, and in addition to this there is an armored deck closing in the ship from stem to stern at the level of the top of the side armor. There is also a special arrangement of armored bulkheads protecting the vital parts of the ship; the magazines, for instance, being completely surrounded with special steel armor.

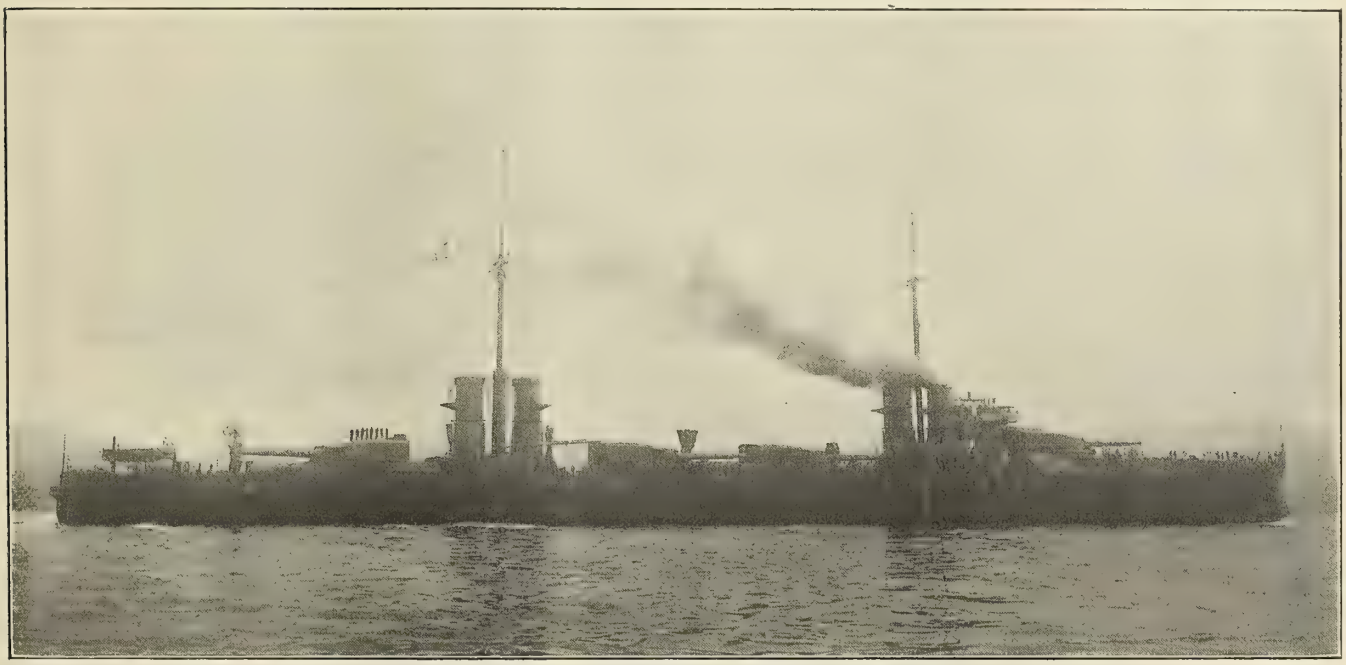


FIG. 1.—ITALY'S FIRST DREADNOUGHT, THE DANTE ALIGHIERI

Principal Data

Like all recent battleships, the *Dante Alighieri* is of familiar all-big-gun type, with principal dimensions as given in Table 1.

TABLE 1.—PRINCIPAL HULL DATA

Length between, perpendiculars, feet and inches	519 2 11/16
Length over all, feet and inches	551 2 7/16
Breadth, extreme at L. W. L. outside of armor, feet and inches	87 1 1/16
Draft to L. W. L., feet and inches	27 15/16
Corresponding displacement, tons	18,400
Ratio of length to beam	5.95

Battery

The main battery consists of twelve 12-inch rifles arranged in four armored turrets on the center line of the vessel. A secondary battery is also provided with twenty 4¾-inch rapid fire guns, eight of which are located in four armored turrets, the other twelve being situated at the sides of the vessel on the battery deck. Further there are thirteen 3-inch rapid fire guns with other smaller guns, together with three submarine torpedo tubes, one located aft just at the water line and two forward at the sides of the vessel.

Steering Gear

The steering gear consists of a right and left-handed screw, connected through nuts and links to the crosshead on the rudder stock. This gear is connected through two lines of shafting and gears respectively to the steering engine and to an electrical motor located in separate compartments. The steering engine is of the vertical double type, with cylinders 16 inches diameter by 12 inches stroke, built by Gio. Ansaldo & Company. This company also furnished the electrical apparatus and all other parts of the steering gear. Four large wheels for hand steering are located in the hand-steering room. Suitable clutches are provided for disconnecting the gear when not in use, which is also the case with the steering engine. The rudder is of the usual balanced type.

Main Engines

The propelling machinery consists of Parsons turbines ar-

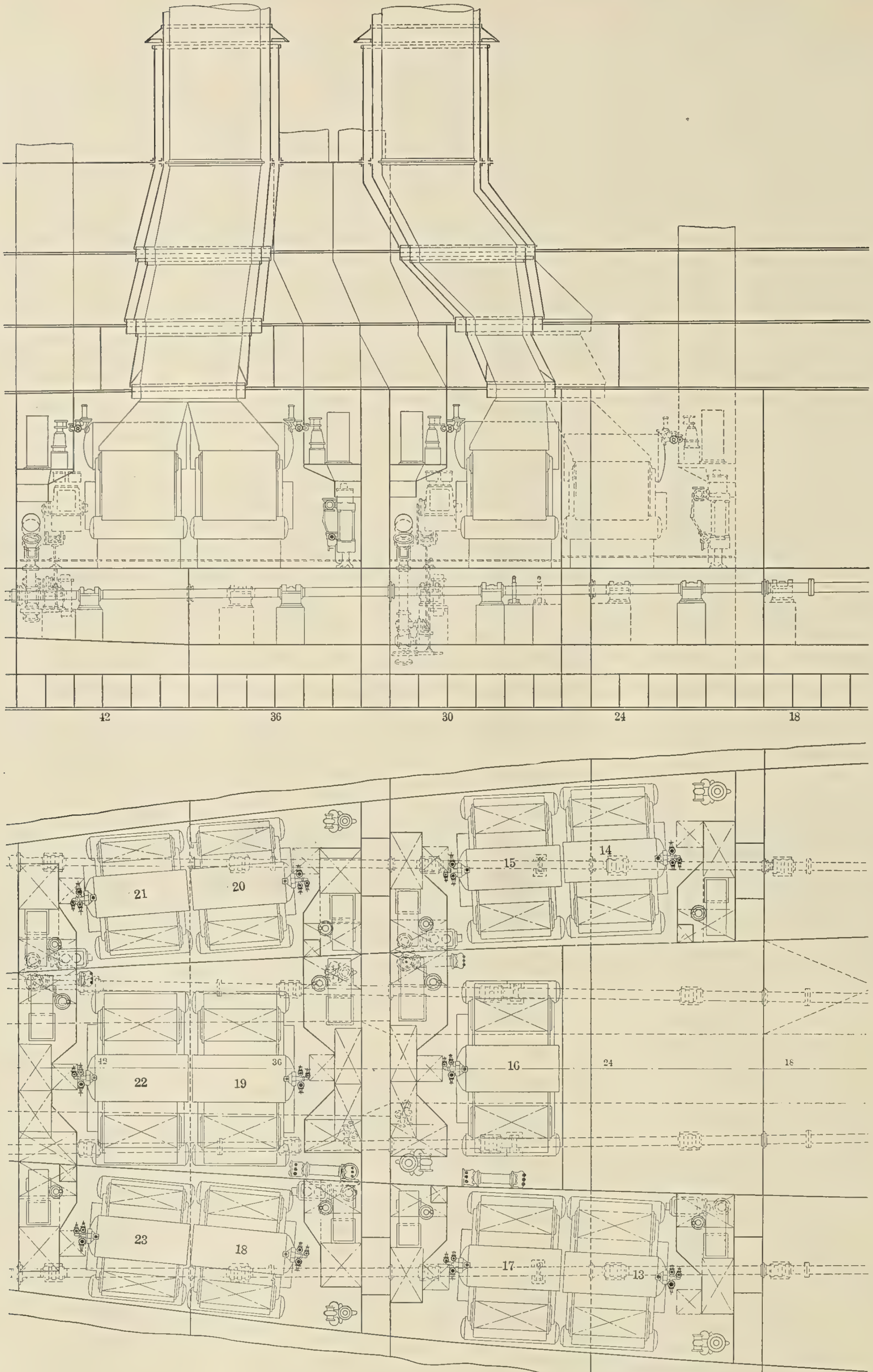


FIG. 2.—AFTER BOILER ROOM

ranged on four lines of shafting (see Fig. 3). The arrangement provides for six ahead and four astern turbines disposed in three watertight compartments. For ahead motion the outboard shafts are driven each by a high-pressure turbine coupled with a low-pressure turbine working in series when the ship runs at full speed, and exhausting into separate condensers. These turbines are designed for 410 revolutions at full power. The inboard port shaft is driven by a main high-pressure turbine (ahead) coupled with a separate astern turbine. The inboard starboard shaft is driven by a low-pressure ahead turbine which has an astern turbine incorporated. These turbines are designed for 330 revolutions at full power.

All six turbines are used for full speed ahead, constituting three separate groups, steam being admitted in each of three high-pressure turbines and expanded through their respective low-pressure turbines into separate condensers. When cruising at slow speed only four turbines are used, steam being admitted to the starboard outboard high-pressure turbine and expanded successively through the port outboard high-pressure turbine, main port inboard high-pressure turbine and the

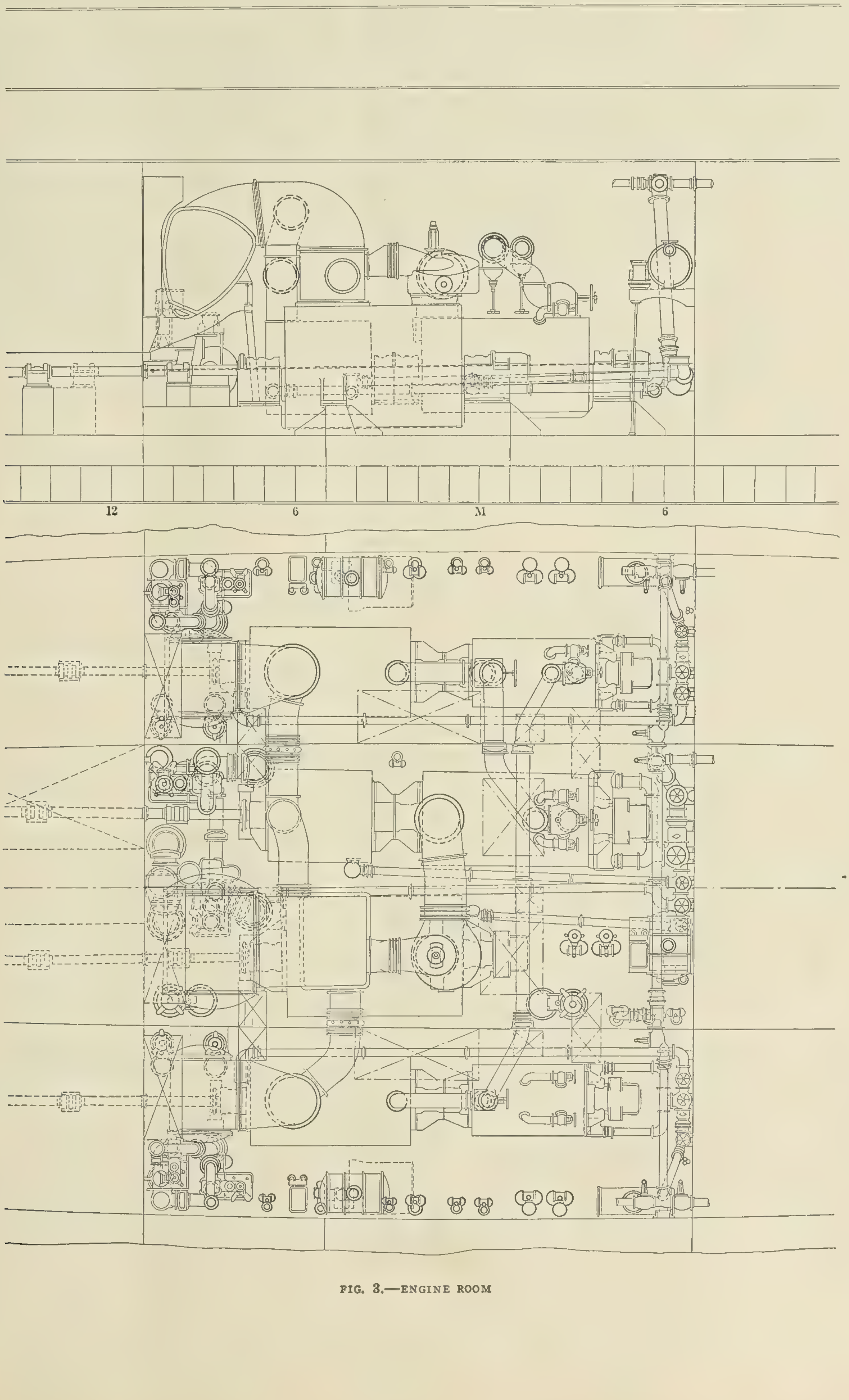


FIG. 3.—ENGINE ROOM

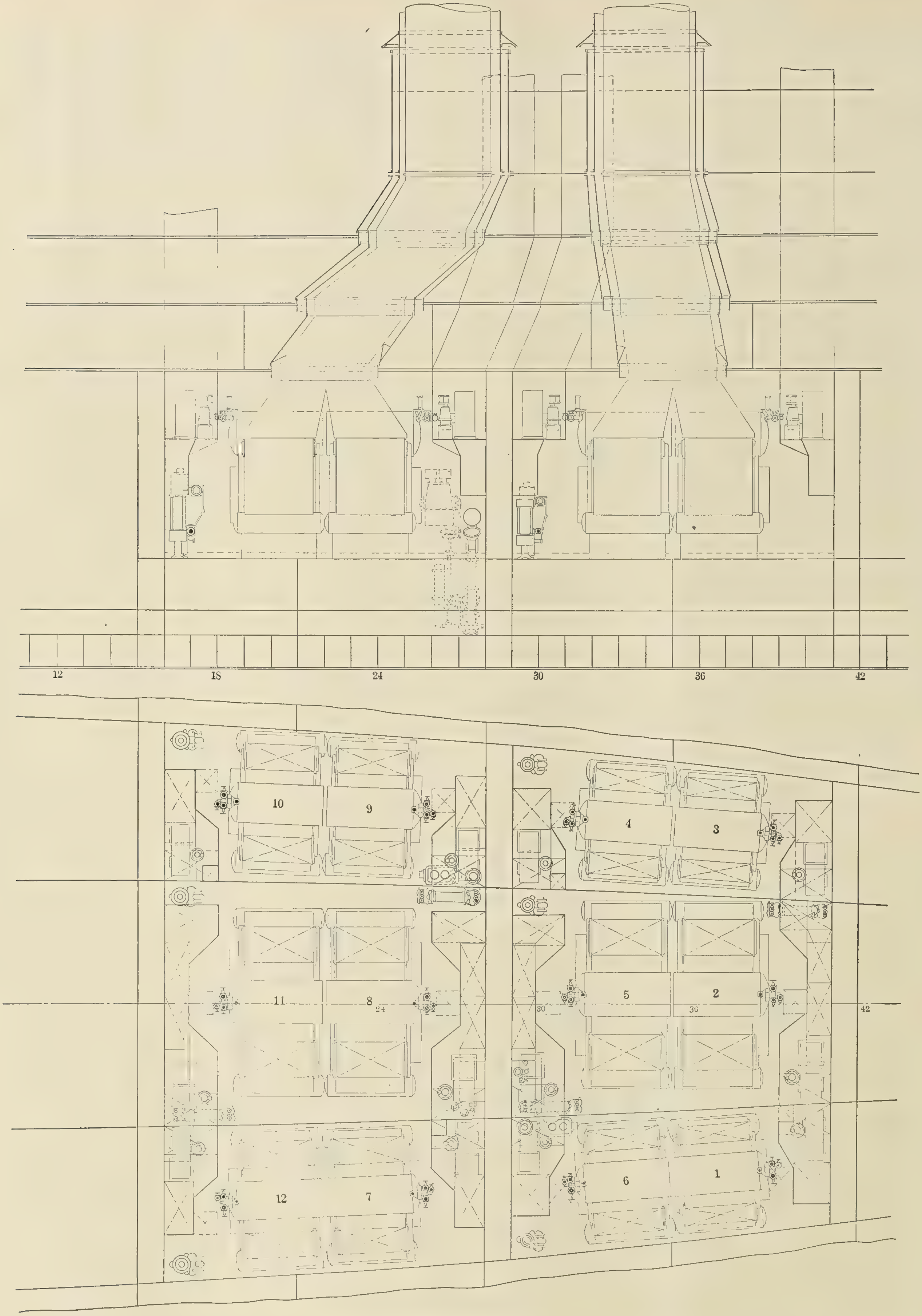
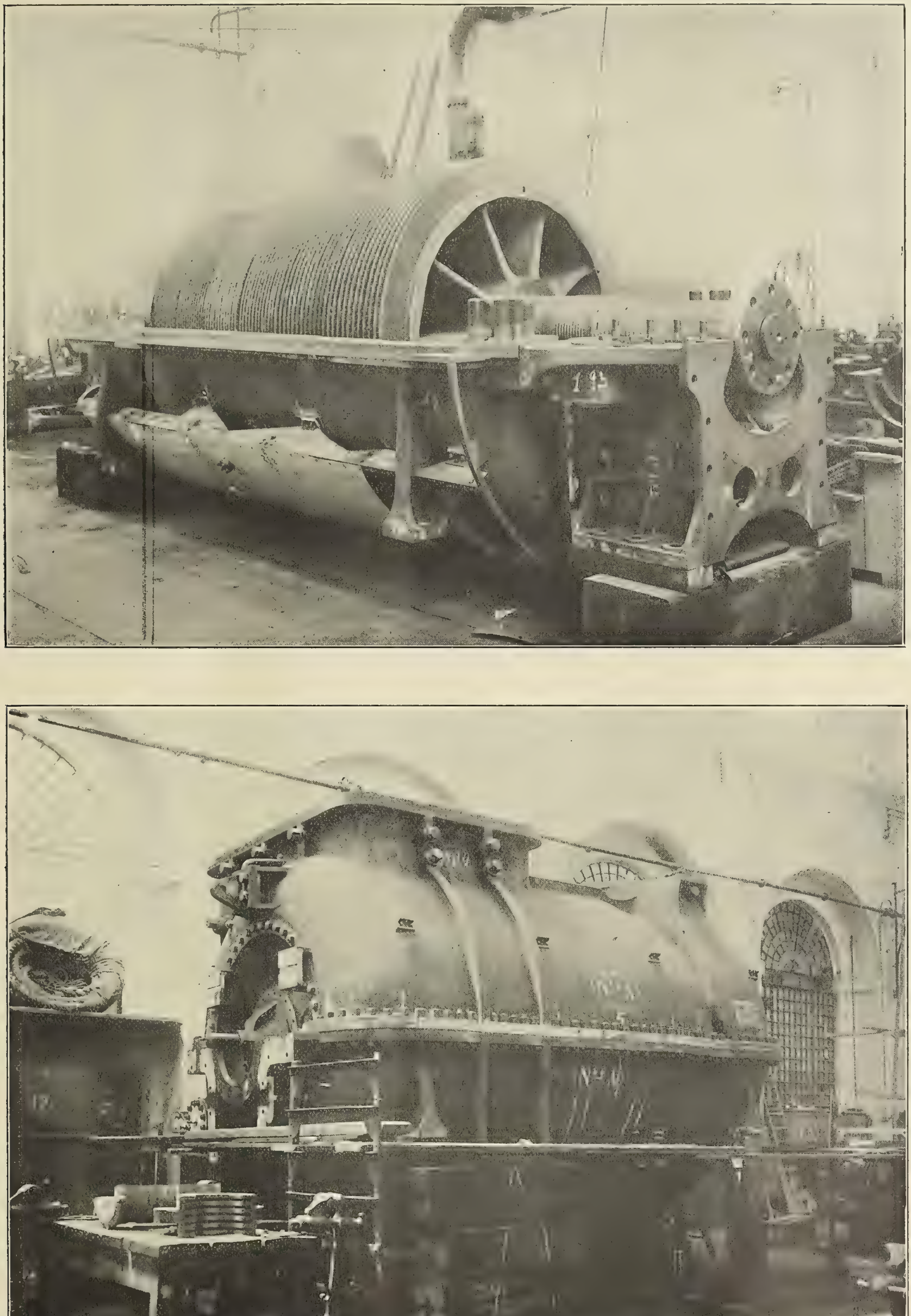


FIG. 4.—FORWARD BOILER ROOM



FIGS. 5 AND 6.—HIGH AND LOW-PRESSURE TURBINES

TABLE 2.—MAIN TURBINE DATA.

Motor Drum.

	Diameter.	Length.
Main central port H. P., inches	68 1/2	116 1/16
Wing starboard H. P., inches	52	89 7/8
Wing port H. P., inches	54	71 5/16
Two wing, L. P., inches	78 3/4	70 7/16
Two wing astern, inches	56	54 9/16
Two central astern, inches	69 5/8	61
Central starboard L. P., inches	95	75 7/8

Number of Expansions.

Main central port H. P	6
Wing starboard H. P	4
Wing port H. P	4
Two wing L. P	6
Two wing astern	4
Two central astern	4
Central starboard L. P	6

Turbine Casings, Diameter, Inches, Each Expansion.

Main central port H. P	70 5/8	71 11/16	73 5/32	75 3/16	78 3/16	82 5/16
Wing port H. P	55	55 3/16	55 9/16	56 11/32		
Wing starboard H. P	54 1/32	54 3/4	55 1/2	56 3/16		
Two wing L. P	81 3/32	83 5/16	85 13/16	85 13/16	85 13/16	85 13/16
Two wing astern	71	72 3/4	70 11/16	70 11/16		
Central starboard L. P	106	101	117	123	123	123

Length of Casing for Each Expansion and Diameter Noted Above.

Main central port H. P., inches	13 7/16	14 15/16	15 5/32	15 5/8		
Wing port H. P., inches	11 7/16	16 3/4	16 3/4	21 7/16		
Wing starboard H. P., inches	18 5/16	19 1/2	20 5/8	21 7/8		
Two wing L. P., inches	10 3/16	10 3/16	12 1/2	12 3/16	12 3/16	12 3/16
Two wing astern, inches	9 3/4	12	12	13		
Two central astern, inches	15	13 3/4	13 3/4	11		
Central starboard L. P., inches	8 1/32	9 7/16	11 3/16	9 3/16	10 3/16	11

Rows of Blading for Each Expansion.

Main central port H. P	12
Wing starboard H. P	16
Wing port H. P	18
Two wing L. P	3 of 7; 3 of 6
Two wing astern	9
Two central astern	11
Central starboard L. P	3 of 6; 3 of 5

Length of Blades for Each Expansion, Inches.

Main central port H. P	14	14	14	11	8	8 1/2
Wing starboard H. P	2 1/8	1 3/4	1 3/8	1 1/16		
Wing port	1 1/16	1 3/16	5/8	1/2		
Two wing	8 1/2	8 1/2	8 1/2	3 9/16	2 5/16	1 5/8
Two wing astern	5/8	1 3/16	2 3/8	2 3/8		
Two central astern	2 9/16	2 9/16	1 1/4	3/8		
Central starboard	14	14	14	11	8	8 1/2

Rotor Shaft and Bearing.

	Length, Inches.	Diameter, Inches.	Length Overall, Rotor, Drum and Shaft, Inches.
Main H. P	17 7/8	13 3/4	278 11/32
Two L. P. wing ahead	24 3/8	11 11/16	259 15/16
H. P. starboard wing	11 21/32	11 11/16	218 1/2
H. P. port wing	11 21/32	11 11/16	236
H. P. astern, independent	13 7/8	13 3/4	172
L. P. central and astern	31	13 3/4	313 3/4

Thrust Bearings.

	Central or Main H. P.	L. P. Ahead.	H. P. Starboard.	H. P. Port.
Collar on shaft, number	11	19	18	18
Thickness, inches	13/16	13/16	11/16	11/16
Distance between, inches	16 9/16	16 9/16	15	15
Outside diameter, inches	11 3/32	11 3/32	16 7/16	16 7/16
Number of shoes, top	18	18	17	17
Number of shoes, bottom	19	19	18	19

TABLE 3.—SHAFT DATA.

	Wing Shafts.	Central Shafts.
Line shafts, diameter outside, inches	10 7/16	11 9/16
Axial hole, inches	5 15/16	6 11/16
Stern tube shafts, diameter outside, inches	11 1/32	12 5/32
Axial hole, inches	5 15/16	6 11/16
Couplings, diameter, inches	17 1/2	19 13/16
Thickness, inches	2 7/16	2 3/4
Propeller shafts, diameter outside, inches	11 21/32	12 5/32
Axial hole, inches	5 15/16	6 11/16
Diameter of sleeve outside, inches	12 9/16	13 3/8
Inside, inches	11 1/8	12 5/16
Length of sleeve, inches. Fore	72 7/16	71 21/32
Aft	95 1/4	95 1/4
Coupling bolts, number each coupling	8	8
Diameter (taper) at face of coupling, inches	1 31/32	2 3/8
Forward stern tube bearings, diameter, inches	15 5/8	16 7/8
Length, inches	54 1/8	54 1/8
After stern tube bearings, diameter, inches	15 5/8	16 7/8
Length, inches	83 1/4	83 1/4

TABLE 4.—PROPELLER DATA.

	Central Propeller.	Wing Propeller.
Diameter of propeller, inches	114 3/4	94
Hub, inches	23 5/8	22
Pitch, inches	108	88
Ratio of diameter to pitch	1.05	1.05
Area projected, square inches	6117.07	4161.75
Helicoidal, square inches	6833.17	6144.20
Disk, square inches	10183.50	6928.50
Ratio projected to disk area	0.6	0.5985
Helicoidal to disk area	6.009	4.49

TABLE 5.—THE UNIFLUX CONDENSERS ARE OF THE FOLLOWING PRINCIPAL DIMENSIONS.

	No. 1 Central Condenser.	No. 2 Lateral Condenser.
Thickness of shell, inches	1/2	5/16
Length between tube sheets, inches	86 1/4	85 1/16
Thickness of tube sheets, inches	1	1
Number of tubes	7938	3344
Diameter of tubes, inches	5/8	5/8
Thickness of tubes, B. W. G.	18	18
Exhaust nozzle, inches	70 1/32 x 81 3/32	33 7/8 x 76 9/16
Air pump suction, inches	14	9
Circulating water inlet and outlet, inches	34	10 7/16
Cooling surface, square feet	12734	3997

TABLE 6.—BOILER DATA.

Number	23
Working pressure, pounds per square inch	235.2
Test pressure, pounds per square inch	308.7
Drum diameter, inches	50
Length, inches	113 7/16
Thickness, inches	9/16
Total grate surface, square feet	1858.08
Ratio G. S. to H. S.	56.01
Total smoke pipe area, square feet	342.51
Kind of forced draft	Closed boiler rooms.
G. S. ÷ area through smoke pipe	5.42

starboard inboard low-pressure ahead turbine, exhausting into the central condenser; the remaining turbines revolving idly in a vacuum.

For astern motion each of the four astern turbines may be used independently of each other.

Self-closing valves are fitted in the receiver pipes between the starboard outboard high-pressure turbine and the port outboard high-pressure turbine, and between that one and main inboard high-pressure turbine (as shown in the drawing) to prevent back flow of steam when changing from the cruising combination to full speed conditions. The turbines

TABLE 7.—R. I. N. DANTE ALIGHIERI. TRIAL DATA.

Duration of Trials in Hours.	Number of Boilers Used.		Air Pressure in Fire Rooms.	Average Steam at Boilers.	Displacement Corresponding.	Draft Mean Before the Trial.				Draft Mean After the Trial.			
						Aft.		For'd.		Aft.		For'd.	
	Coal Boilers.	Oil Boilers.	Inches of Water	Pounds.	Tons.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.
10	4	2	1½ to 1¾	189 to 226	18,230	28	10	28	5	26	1	28	4
18	23		1½ to 1¾	220.5	18,300	26	4	28	8	26	1	28	3
6	23		1½ to 1¾	225.5	18,200	26	3	28	6	26	..	28	3

Duration of Trials in Hours.	Slip of Propellers, Percent of Own Speed, Mean.		Speed in Knots.	Revolutions.				Power, I. H. P.	Coal Consumption. Pounds.
	Side.	Central.		Starboard Outboard Shaft.	Port Outboard Shaft.	Starboard Inboard Shaft.	Port Inboard Shaft.		
10	7.19	8.46	11.29	164	167	152	152	29,910	2.31
18	14.63	20.43	19.767–23.825	313	324	281	276	20,501	1.67
6	21.53	18.18	22.83 –23.825	398	400	317	317	32,189	1.56

are controlled from the working platform, where the regulating valves for admitting steam to the different turbines are located.

There is a main bearing at each end of each turbine for carrying the rotor. Each turbine, except the independent high-pressure (inboard astern) and the outboard low-pressure turbines coupled with its high-pressure turbine is provided with a thrust block at the forward end, consisting of a number of brass rings, in halves, fitting into corresponding collars on the shafts. The lower half of each ring is for taking the ahead and the upper half the astern thrust.

All main bearings, thrust bearings, and the line shaft bearings are provided with a closed system of forced lubrication.

A Proell governor is fitted to each line of shafting, the governor mechanism operating the main steam stop valves in the engine room.

For main turbine data see Table 2.

Shafting

There are four lines of shafting, two on the port and starboard sides respectively. (For data see Table 3.)

Propellers

There are four three-bladed propellers, all outboard turning when going ahead. The blades are true screw-machined to pitch. (For propeller data see Table 4.)

Main Condensing Apparatus

There is one main condenser in each engine room. The starboard and port condensers are of the same dimensions, the central condenser is larger than the latter. (For condenser dimensions see Table 5.)

Auxiliary Machinery

In each engine room there are air pumps, circulating pumps, auxiliary condenser, fire and bilge pumps, pumps for the forced lubrication system, etc.

Boilers

There are twenty-three boilers of watertube type arranged in separate watertight compartments. They are designed to run the entire machinery installation at full power, with an average air pressure in the ash pits of not more than 1½ inches of water. (For boiler data see Table 6.)

Trials

Three trials were required of the *Dante Alighieri* as follows:

1. A full-speed trial of six hours' duration in the open sea at the highest speed obtainable, with an average air pressure in the ash pits not exceeding 1½ inches of water with not over 195 pounds steam pressure at the high-pressure turbines. The average power to be 26,000 shaft horsepower.

This trial took place at sea off Spezia on July 9. The designed speed was easily exceeded, an average speed being attained which set a new record in the navy for battleships.

2. An endurance and water and coal consumption trial in the open sea of eighteen hours' duration with an average power to be at least 16,500 shaft horsepower, to be followed with another six hours' duration trial for the purpose of obtaining complete data for all conditions of running which might be required in battle.

This trial took place successfully on July 16 and 17, with an average power of 20,501 shaft horsepower and a mean speed of 19.75 knots.

TABLE 8.—R. I. N. DANTE ALIGHIERI FULL POWER TRIAL DATA, JULY 9, 1912.

Time	Steam Pressure in the Turbines and Vacuum of Condensers.								
	H. P. Starboard	L. P. Starboard	Starboard Condenser	H. P. Port	L. P. Port	Port Condenser	H. P. Central	L. P. Central	Central Condenser
	Pounds	Pounds	Inches	Pounds	Pounds	Inches	Pounds	Pounds	Inches
12:5	182	21	25.2	119	23	26.1	125	0.7	27.9
12:35	189	24	26.4	119	23	26.1	139	2.1	27.9
13:5	186	19	26.7	104	20	28.4	139	3.5	27.9
13:35	182	18	26.1	102	18	28.4	136	3.1	27.9
14:5	186	19	26.1	111	21	28.4	145	4.2	27.9
14:35	183	20	25.8	111	21	28.4	145	4.2	27.9
15:5	182	21	25.8	111	21	26.1	143	4.5	27.9
15:35	179	20	25.8	110	20	28.4	142	4.2	27.9
16:5	179	20	26.1	110	21	28.4	140	4.2	27.9
16:35	186	20	25.8	112	21	28.4	140	4.4	27.9
17:5	182	20	26.1	111	21	28.4	143	4.9	27.9
17:35	182	20	25.8	111	20	28.4	145	4.8	27.9
18:5	170	17	26.1	111	21	28.4	139	4.1	27.9

Time	REVOLUTIONS.				S. H. P.				
	Side Starboard Turbine	Side Port Turbine	Central Starboard Turbine	Central Port Turbine	Side Starboard Turbine	Side Port Turbine	Central Starboard Turbine	Central Port Turbine	Total
12:5	385.5	395.5	300	297.5	6184.9	7808.4	7306.6	7333.5	28633.4
12:35	396	404	313	308	6832.4	7776.8	8474.8	8001.2	31085.2
13:5	392.5	396	316	312.5	6673.1	7467.8	8695.2	8402.8	31238.9
13:35	380	385	302.5	302.5	6658.1	7411.1	8598	8787.5	31455.1
14:5	391	404.5	315	314.5	6601.6	7834.7	8839.1	8669.4	31944.8
14:35	401.5	403.5	320	316	7298.3	7863.4	9219.8	8743.7	33125.2
15:5	402	402	319	317	7226.4	7820.4	9091.8	8837.4	32976
15:35	390	405	318	316.5	6539	8002.9	9063.3	8839.9	32445
16:5	399	408	319.5	317	7038.6	8048.3	8965.3	8721.8	32774
16:35	402.5	401	316.5	321.5	7079.8	7876.1	8995.9	8954.4	32906.2
17:5	398.5	397.5	317	313.5	6828.7	7800.5	8813	8699	32141.2
17:35	394.5	402.5	316.5	314.5	6773.4	8015.1	8856.6	8702.2	32347.3
18:5									

Total coal consumed in 6 hours = 76.5 tons.
Total oil fuel consumed in 6 hours = 39.5 tons.
Oil fuel reduced to coal = 53 tons.

Total as coal = 129.5 tons.

Mean coal consumption per hour = 47627 pounds.
Mean S. H. P. developed according:

$$\frac{\Sigma \frac{P}{N^3} N_c^3}{12} = 32189.9$$

Coal consumption per S. H. P. per hour $= \frac{47627}{32189} = 1.5$ lbs.

3. An endurance and water and coal consumption trial in the open sea of ten hours' duration running at low cruising speed.

This trial took place on July 24, the data of which are given in Table 7.

The results of all trials were most satisfactory and reflect great credit not only on the navy yard force, where the vessel was built, and the Gio. Ansaldo & Company's works, where the machinery was constructed, but particularly on the ship's engineering force from the navy and the builders, the organization, skill and energy of which displayed in handling the machinery throughout the trials were largely responsible for the success.

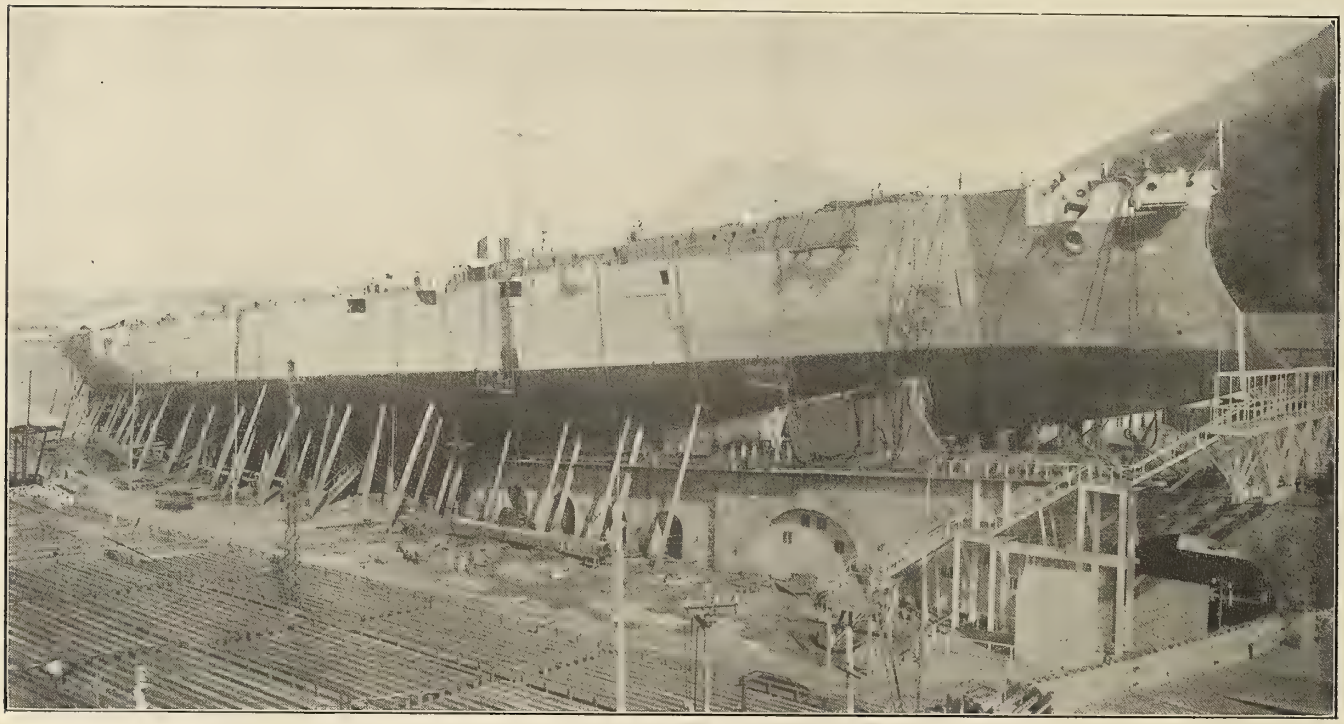


FIG. 7.—THE DANTE ALIGHIERI JUST BEFORE LAUNCHING

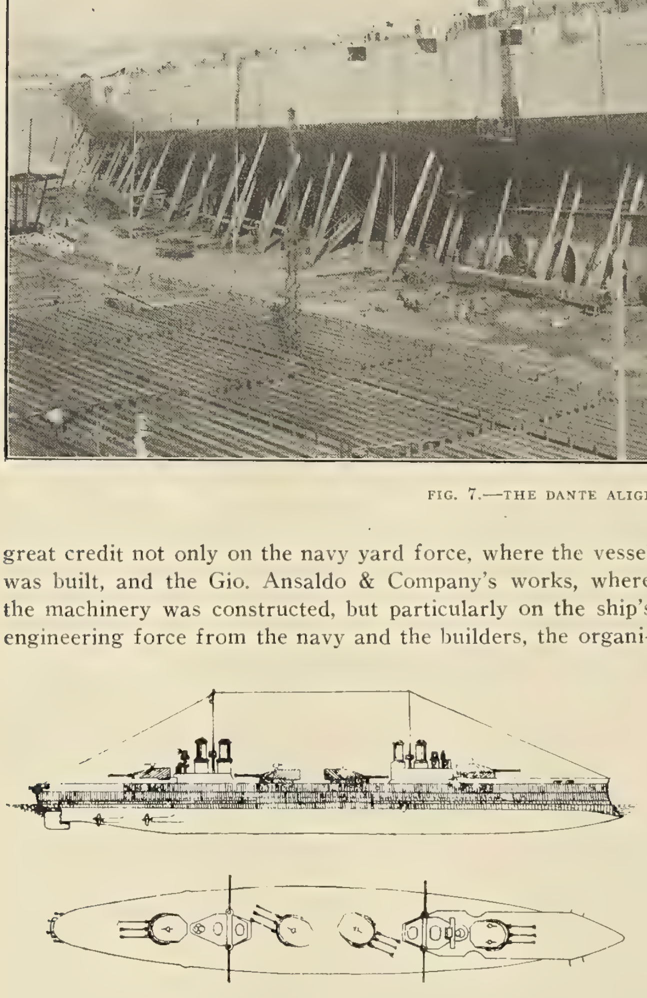


FIG. 8.—DIAGRAM SHOWING POSITION OF GUNS AND ARMOR

MONTHLY SHIPBUILDING RETURNS.—The Bureau of Navigation reports 140 sailing, steam and unrigged vessels of 33,006 gross tons built in the United States and officially numbered during the month of October, 1912. Five steel steamships aggregating 10,851 gross tons were built on the Atlantic coast, and four steel steamships with a total of 4,939 gross tons were built on the Great Lakes. The largest of these vessels were the *Middlesex,* of 4,727 gross tons, and the *El Segundo,* of 3,663 gross tons, both of which were built at the New York Shipbuilding yards, Camden, N. J.

Annual Report of Lloyd's Register of Shipping

According to the annual report of *Lloyd's Register of Shipping* at the close of the year ended June 30, 1912, there were 10,445 merchant vessels registering about 21,750,000 tons gross classed in the society's books. During the year classes were assigned by the committee to 684 new vessels of 1,468,166 gross tons. These figures represent 623 steamers of 1,455,988 tons and 61 sailing vessels of 21,178 tons. Of the total, about 68½ percent were built for the United Kingdom, and about 31½ percent for the British colonies and foreign countries. As compared with the figures for the preceding twelve months, the present reports following the general movement of the shipbuilding industry show an increase of 366,865 tons of steamships and 2,825 of sailing vessels.

A noticeable feature of the society's operations during the past year is the large number of steamers of upwards of 5,000 tons each which have received the 100 A-1 class. Eighty-six such vessels have been so classed this year.

The initial success of the Diesel engine for marine purposes is recognized. At the present time there is under construction under the supervision of *Lloyd's Register* Diesel engines for thirty-four vessels, twenty-three of these vessels having tonnages ranging from 2,000 to 10,000. It is evident that the construction of such vessels is rapidly increasing, more especially in Holland and Germany. It is felt, however, that the time has hardly yet arrived for the provision of rules on this subject.

An increasing amount of tonnage is being built for the society's classification on the Isherwood system. Up to the end of June, 64 of these vessels of 264,368 tons had received the society's classification. Since that date, 114 such vessels, registering 593,400 tons, have been completed, or are under course of construction, under the special survey of the society's surveyors.

The demand for new steamers intended for carrying oil in bulk has also enormously increased. Since July 1, 1911, 16 vessels of 66,911 tons, intended to be used for this purpose, have been assigned the society's classification, while there are

under construction, at home and abroad, no less than 87 vessels registering 479,000 tons for this purpose. In connection with the increase in the number of vessels under construction for carrying oil in bulk, there is also a great development taking place in the use of oil fuel instead of coal. From Jan. 1, 1910, to the present time there have been completed under the survey of the society's surveyors 15 oil-carrying vessels and 19 other vessels constructed with oil-fuel bunkers. At the present time oil-fuel bunkers are being constructed in 45 oil-carrying vessels and in 19 other vessels which are being built under the society's survey.

The period under review has witnessed a noticeable extension of the society's operations in the United States, where 40 vessels of 175,000 tons are now in course of construction for classification in Lloyd's registry book. Seventeen of these ships, aggregating 63,000 tons, are building on the Great Lakes.

Passage of Vessels through the Panama Canal

From the annual report of the Isthmian Canal Commission, just issued, it is apparent that the first vessel will pass through the canal some time during the summer or fall of 1913, although the official opening of the canal to the world's commerce will be considerably later, probably not before Jan. 1, 1915. Before the official opening of the canal for international traffic there is is a vast amount of detail work to be finished in connection with facilities for docking and repairing vessels, furnishing supplies of coal, oil, means for handling and transshipping freight and the provision of facilities for the operating staff.

When the canal is finished vessels will not be permitted to enter or pass through the locks under their own power, but will be towed through at the rate of 2 miles an hour by electric locomotives running on cog-rails laid on the tops of the lock walls. Electric power for towing the vessels and also for operating all gates and valves is to be generated by water turbines from the head created by Gatun Lake. When a ship is to pass through the canal it will come to a full stop in the forebay of the locks, where four hawsers will be attached to it, two forward on either side and two aft. At the other ends these hawsers will be attached to the windlasses of four towing locomotives operating on the lock walls, two forward for towing and two aft being towed by their hawsers, thus holding the ship steady. While the usual number of locomotives will be four, this will vary, of course, with the size of the vessel to be towed. The locomotives are equipped with a slip drum, towing windlass and hawser, which will permit the towing line to be taken in or paid out without actual motion of the locomotive on the track.

The locomotives will run on a level, excepting where they pass from one lock to another, where they will encounter heavy grades; between the lower and intermediate locks at Gatun, for example, there is a difference in elevation of 29 feet 7 inches, and in order to save concrete this ascent is made in the shortest feasible distance.

There will be two systems of tracks, one for towing and the other for the return of the locomotives when not towing. The only cross-over between the tracks will be at each end of the locks, and there will be no switches in the rack road.

The depth of water over the miter sills of the locks will be 40 feet in salt water and 41 1/3 feet in fresh water. The average time of filling and emptying a lock will be about 15 minutes, without opening the valves so suddenly as to create disturbing currents in the locks or approaches. The time required to pass a vessel through all the locks is estimated at three hours—one and one-half hours in the three locks on Gatun and about the same time in the three locks on the Pacific side. The time of passage of a vessel through the entire canal is estimated as ranging from 10 to 12 hours, according to the size of the ship and the rate of speed at which it can travel outside of the locks.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

	Tons.	Knots.		Aug. 1.	Nov. 1.
BATTLESHIPS					
New York	28,000	21	Navy Yard, New York	48.2	62.5
Texas	28,000	21	Newport News Shipb'g Co.	72.1	79.2
Nevada	28,000	20½	Fore River Shipb'g Co.	4.0	10.1
Oklahoma	28,000	20½	New York Shipb'g Co.	3.3	9.3
TORPEDO BOAT DESTROYERS					
Henley	742	29½	Fore River Shipb'g Co.	93.6	96.9
Cassin	742	29½	Bath Iron Works	42.3	60.4
Cummings	742	29½	Bath Iron Works	30.7	52.7
Downes	742	29½	New York Shipb'g Co.	16.4	25.0
Duncan	742	29½	Fore River Shipb'g Co.	34.3	44.4
Aylwin	742	29½	Wm. Cramp & Sons	48.0	61.3
Parker	742	20½	Wm. Cramp & Sons	42.2	56.6
Benham	742	29½	Wm. Cramp & Sons	38.9	56.0
Balch	742	29½	Wm. Cramp & Sons	37.3	58.6
SUBMARINE TORPEDO BOATS					
F-4	....	....	Seattle Con. & D. D. Co.	90.8	94.6
G-4	....	....	Wm. Cramp & Sons	79.5	88.3
G-2	....	....	Newport News Shipb'g Co.	86.0	86.0
H-1	....	....	Union Iron Works	76.2	84.5
H-2	....	....	Union Iron Works	75.7	84.5
H-3	....	....	Seattle Con & D. D. Co.	73.3	82.1
G-3	....	....	Lake T. B. Co.	54.9	60.0
K-1	....	....	Fore River Shipb'g Co.	43.9	54.2
K-2	....	....	Fore River Shipb'g Co.	43.4	53.5
K-3	....	....	Union Iron Works	47.9	59.0
K-4	....	....	Seattle Con. & D. D. Co.	40.7	54.5
K-5	....	....	Fore River Shipb'g Co.	26.2	38.6
K-6	....	....	Fore River Shipb'g Co.	25.8	38.1
K-7	....	....	Union Iron Works	28.2	42.0
K-8	....	....	Union Iron Works	28.2	41.5
COLLIERS					
Proteus	20,000	14	Newport News Shipb'g Co.	61.9	72.0
Nereus	20,000	14	Newport News Shipb'g Co.	56.7	62.5
Jason	20,000	14	Maryland Steel Co.	47.7	66.7
Jupiter	20,000	14	Navy Yard, Mare Island	78.2	85.6

Panama Canal Tolls

In a proclamation issued Nov. 13, President Taft fixed the rates of tolls on vessels passing through the Panama Canal as follows:

1. On merchant vessels carrying passengers or cargo, $1.20 (5s.) per net vessel ton—each 100 cubic feet—of actual earning capacity.

2. On vessels in ballast without passengers or cargo, 40 percent less than the rate of tolls for vessels with passengers or cargo.

3. Upon naval vessels other than transports, colliers, hospital ships and supply ships, 50 cents (2s. 1d.) per displacement ton.

4. Upon army and navy transports, colliers, hospital ships and supply ships, $1.20 (5s.) per net ton, the vessels to be measured by the same rules as are employed in determining the net tonnage of merchant vessels.

Th Secretary of War will prepare and prescribe such rules for the measurement of vessels and such regulations as may be necessary and proper to carry this proclamation into full force and effect.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meeting of the Institution of Naval Architects for 1913 will be held in London, March 12, 13 and 14. All papers or suggestions for discussion at this meeting should be sent to the secretary before the first of the year.

Engineering Progress in the United States Navy*

BY CAPTAIN C. W. DYSON, U. S. N.

In preparing an article under the heading of "Engineering Progress in the United States Navy," the ground to be covered is of such large extent that, in the greater part, nothing but the merest notice of improvements can be given, and only the most important points of progress will be detailed. The first and most important point of all as reacting upon the general efficiency of the navy as a reliable and economical fighting force, is the

Choice of Propelling Machinery for Heavy Vessels of Moderate Speed

In the selection of the type of machinery to be used in the above class of vessels, the following points must be taken into consideration:

(*a*) General character of the service which the vessel will be called upon to perform; whether she must keep the sea for long periods, cruising at speeds very much lower than her maximum speeds, or whether she will be called upon for very little slow cruising, but shall be held in readiness for dashes at high speed from a base to any threatened point.

(*b*) Greatest economy realized at the conditions under which she will be called upon to operate. This point is important, not only from the point of financial saving in reduced fuel cost, but in the greater case of fuel supply due to the decreased demands.

(*c*) Fuel capacity entailed by the demands of the service to which the vessel may be subjected.

(*d*) Ease of up-keep of the machinery, and degree to which the vessel, so far as machinery repairs are concerned, can be made self-supporting.

(*e*) Reliability of machinery when driven at high powers.

(*f*) Minimum weight and space required for the propelling machinery.

(*g*) Efficient propellers for maneuvering.

(*h*) Minimum of vibration of hull due to machinery in operation.

(*i*) Effect of vertical position of center of gravity of the machinery upon the time of roll of the vessel, in fixing the quality of the vessel as a gun platform.

The question of costs of the different types of machinery will not be considered in comparing the relative advantages of the types.

Further, the relative values of turbine reduction gear, electric propulsion and internal combustion engines for propulsion will not be dealt with, for the following reasons: The turbine reduction gear and electric propulsion are under trial in the naval service at the present time, the reduction gear being actually afloat while the vessel fitted with electric propulsion is building.

The results obtained up to date with the reduction gear have been disappointing so far as the expected economy is concerned, the results being vitiated by faulty turbines and too high a number of revolutions of propeller, 135 per minute, for the type of vessel and the speed, 14 knots. The reduction gears have, however, stood up to the work well and show practically no evidences of wear. Results are encouraging and a great improvement is expected when contemplated changes in the turbine have been made.

Electric propulsion not having been tried out in actual service, it is considered preferable to content ourselves with the mere statement that shop tests of one of the units have been very gratifying and promise a successful end to the experiment, so far as economy of propulsion only is considered.

As to the question of propulsion by internal combustion engines, where large powers are required, there appear still to be many important problems requiring solution before units of sufficiently high powers for the purpose desired can be built. The supplanting of the steam engine, both reciprocating and turbine, for important high-power installations does not appear to be imminent in the immediate future.

Eliminating these three latter methods of propelling naval vessels restricts the choice of machinery for this purpose to the three following methods:

1. By means of reciprocating engines.

2. By means of steam turbines, impulse, reaction, or a combination of the two.

3. By means of various combinations of reciprocating engines with turbines.

Comparative Suitability of Each of the Above Methods for Naval Purposes

To assist in reaching a decision as to which of the three methods of propulsion best meets the requirements lettered from (*a*) to (*i*), a comparison of the performances of the dreadnoughts *Delaware, North Dakota, Utah,* and *Florida* can be made; these performances include those on preliminary acceptance trials and those in actual service.

From the results obtained from these trials it appears justifiable to decide as follows:

Should the duties of a vessel be such that she be required to steam for long periods and long distances at speeds much lower than her designed maximum speed, a less fuel expenditure per day will be required, and consequently a greater cruising radius will be obtained and less frequent recoaling necessitated should reciprocating engines be fitted rather than turbines for propelling purposes.

Should, however, the vessel operate from a fixed base, only doing sufficient cruising to insure that the machinery is kept in efficient condition in readiness for forced runs to any threatened point, the value of fuel economy at low speeds becomes minimized and, where the maximum speed of the vessel does not exceed 21 to 22 knots, either turbines or reciprocating engines may be used, the choice being dependent upon other factors than economics, which are practically equal at these speeds.

In other words, for the conditions (*b*) and (*c*), under which the American battleship fleet operates, the reciprocating engine is preferable to the turbine as a propelling engine at the present stage of turbine development.

The Navy Department is, however, thoroughly alive to the advantages to be gained by adopting rotary in place of reciprocating motion in the main propelling machinery of the heavy vessels of the fleet, and, while recognizing the present advantages held by the reciprocating engine in the matter of economy at low fractions of designed power, holds itself ready to discard the reciprocating engine as soon as the turbine designers can demonstrate by actual performance that their claims as to equality of economy at low powers with the older machine have been realized. It was with this object in view that the department decided to install impulse turbines in the *Nevada,* and not because the engineers of the department were "wobbling," as has been charged.

Condition (*d*)—*Ease of Up-keep of Machinery.*—The claim is frequently made by the turbine advocates that while the

* From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1912.

reciprocating engine, when new, is undoubtedly more economical than the turbine at small fractions of designed power, this advantage is soon lost in active service, due to excessive wear of piston and valve rings causing large losses through heavy leakage of steam. The turbines, not being subject to such frictional wear, would, on the other hand, retain their original economy indefinitely.

Practical experience with both types of engine in actual service comes very far from justifying this conclusion. In fact, with intelligent supervision, the reciprocating engine, particularly since forced lubrication has been applied, holds its superiority continuously.

When reciprocating engine vessels visit the navy yards for their regular overhaul, the work to be done on the main engines is practically nil, as the machine shops and foundries of the battleships are of ample capacity to take care of all repairs that may be necessary except such as the fitting of a new cylinder or the repair of a fractured bed plate. The above remarks apply only, however, to ships fitted with forced lubrication, where the wear of bearings and journals has been practically eliminated.

When we turn to the turbine engines, however, the case is quite the opposite. Fully 99 percent of the troubles that occur with this type of engine are internal troubles, and consist of erosion of blades and nozzles, stripping of blading, heavy corrosion of rotors, diaphragms and turbine wheels, causing destruction of balance. All of these troubles require a perfectly smooth haven in which to make repairs, and the majority of them require dock-yard facilities.

In the cases of the main engines of the three scouts—*Birmingham, Salem* and *Chester*—the *Birmingham,* with reciprocating engines, has always been ready for service, while her two sisters have been repeatedly laid up at the yards for overhaul of the main turbines.

Evidence of experience leads to the conclusion that a battleship fitted with reciprocating engines for propelling purposes is much less apt to be forced off her station by necessary repairs to her engines than is one fitted with turbine engines.

Condition (e)—Reliability of Machinery when Driven at High Powers.—From the natures of the two machines, it would appear to be safe to decide this condition as being distinctly in favor of the turbines, as this type of engine is completely free from all reciprocating parts held together by bolts and nuts.

Experience with the *Delaware's* engines, however, lead to the conclusion that where proper care is taken to lock all nuts securely, and to effectively protect the engines against the shocks of reversal of direction of motion, the reciprocating engine can, even here, be regarded as nearly on a par with the turbine in reliability.

The full-power twenty-four hour run of the *Delaware,* made without preparation immediately after her arrival home from Chili, demonstrates this reliability of the present type of battleship engines very thoroughly. As stated, without any preliminary preparation of engines or machinery, the vessel put to sea, and upon getting well clear of the land a full-power run of four hours was started, during which time the vessel averaged 21.86 knots. Without intermission the vessel continued on for twenty hours longer, averaging for the full twenty-four hours a speed of 21.3 knots, the ship automatically slowing down as the fires became dirty and the personnel fatigued.

Upon the completion of the trial a radiogram was received from the commanding officer of the vessel reporting that not the slightest disarrangement had occurred to either the main engines or the auxiliary machinery, and that she was ready for immediate service.

Condition for Minimum Weight and Space Required for the Propelling Machinery.—As already shown, the total heat units required to be absorbed by the boilers, both for Parsons turbines and for reciprocating engines, with battleships of the speed and power that now exist, is practically the same in both cases at full power. This indicates that, for existing conditions, nothing can be saved in the boiler-room weights or space by adopting turbines, as the same boiler power is required in the two cases.

In the engine rooms, for these powers, however, the reciprocating engine has a decided advantage in both weight and space required.

Thus, in the *Delaware, North Dakota,* and *Utah* the engine room weights and space required are as follows:

	Delaware.	*North Dakota.*	*Utah.*
Engine-room weights, dry tons.........	728.26	731.23	864.69
Engine-room weights, wet tons.........	773.26	785.93	919.80
Engine-rooms, length, feet............	44	44	60
Engine-room total width, feet.........	50.5	50.5	51
Engine-room, square feet, floor space..	2,222	2,222	3,060

While the turbines of the *North Dakota* appear to be about on an equality with the reciprocating engines of the *Delaware* in the matters of weight and space, these turbines were extremely uneconomical. Modern turbines of this type would require an engine room more nearly equal in length to that of the *Utah,* and the engine-room weights would be considerably increased.

While the reciprocating engine has a decided advantage in the features of weight and space required, under present conditions, these advantages would disappear should the necessary power to be developed be increased considerably above what is now asked for, and the advantages would rest with the turbine. Should such an increase of power be called for in future designs, or should the ordinary cruising speed be made considerably higher than now used, the Navy Department would undoubtedly abandon the reciprocating engine and adopt one of its rotary rivals for the propulsion of its capital ships.

Condition (g)—Efficient Propellers for Maneuvering.—In considering this condition, the relation of the backing powers of the vessel as compared with the maximum full power ahead, and the time required from full speed ahead until the vessel is dead in the water, will be taken as a comparative measure of this condition.

From curves of indicated horsepower for backing for the *Delaware* (reciprocating engines) and of shaft horsepower for backing for the *Salem* (turbine engines), it is found that at low powers where more boiler power is always available than is necessary for the actual ahead speed being used, the backing power exceeds very considerably the ahead power in use, as when backing for short periods the throttles can be opened wide and the boiler power available be made use of.

When all boilers are in use, which in the case of the *Delaware* occurs at 25,000 indicated horsepower for the main engines in the ahead motion, and for the *Salem* at 14,000 shaft horsepower for the main engines in the ahead motion, the maximum backing powers can be obtained. In the case of the *Delaware* this maximum backing power amounts to 89.2 percent of the ahead power, while in the turbine vessel *Salem* it amounts to only 41.9 percent. That is, at these points, the backing power of the *Delaware* is 2.13 times as great as that of the *Salem* (both being expressed as fractions of the ahead power).

At the maximum powers developed by the engines of the two vessels, the ratio of the percentage backing powers becomes: *Delaware* = 2.27 *Salem.*

These results are further corroborated by the backing tests of the *Delaware* and the *Utah* upon their preliminary acceptance trials, where, with the *Delaware* going ahead at 21 knots and the *Utah* at 20, the times taken to bring the vessels dead in the water were, for the *Delaware,* 1 minute 52 seconds; *Utah,* 4 minutes 44 seconds.

	Delaware.	*Utah.*
Backing power divided by ahead power....	87.5 percent	35.7 percent

These results are still further corroborated by the destroyers. These vessels can easily steam ahead at 16 knots under one boiler, but when called upon to maneuver they invariably, as a matter of safety, start a second boiler.

Conditions (h) and (i)—Minimum Vibration of Hull; Steadiness of Hull as a Gun Platform as Affected by Machinery.—In judging these points it seems only fair to base the decision upon the results of target practice of the vessels in service. If this is done, the decision could be given to the reciprocating type of machinery, as the *Delaware* has just won the championship of the battleship fleet, with the *Colorado,* another reciprocating engine vessel, standing second on the list. From these results it appears reasonable to state that, with well-balanced reciprocating engines, no ill effects on gun fire should be expected.

Conclusions

Basing the choice between reciprocating engines and turbines for battleship propulsion under existing conditions of speed and power upon the above comparison of relative advantages of the two types, the advantage appears to rest most decidedly with the reciprocating engines, and the Navy Department has ruled accordingly.

Combination System

In the search for economy of propulsion through a wide range of speeds, various combinations of reciprocating engines and turbines have been proposed, both by the Bureau of Steam Engineering and by the shipbuilders, but only one of the systems has as yet been authorized, and that one is for destroyers. It had not yet been tried out in service, but preliminary shop tests show a good gain in economy of the main propelling engines at cruising speeds. This system, as applied to the destroyers, depends entirely for its gain upon the greater efficiency of the reciprocating engine at the higher steam pressures over the efficiency of high-pressure turbines of the reaction and the high-pressure nozzles of the impulse type of turbines, no advantage being gained from increased efficiency of propellers, as the reciprocating engines are on the same shafts as the turbines. From some points of view this combination is undesirable, and the gain in service must be considerable to justify its retention.

With the other combination systems proposed, calculations indicate that if the propulsive efficiency counted upon can be obtained, these systems will all be very much more efficient than either a straight turbine or straight reciprocating engine drive at maximum power, will hold a big advantage over the straight turbine drive through all ranges of powers, and will hold its advantage over the straight reciprocating engine drive until a minimum speed of about 11 knots is reached, when the efficiencies become equal.

The "if" exists, however, and is caused by the danger of the currents thrown to the rear by the big reciprocating engine screws seriously affecting the rate of feed and direction of flow of water to the turbine propellers. In addition, there may possibly be another source of loss due to heavy leakage of steam through the large change valves which must be fitted to control the paths of flow of the exhaust steam from the reciprocating engines.

In all of these systems, to adapt them to naval requirements, it is necessary to exhaust from the low-pressure cylinders of the reciprocating engines at a pressure of not less than 25 pounds absolute, when this engine is operating at full power, and to by-pass as few of the stages of the turbine as possible in order to obtain an increased economy of propulsion through a large range of powers.

Turbine Changes to Produce Increased Economy

The Parsons turbine as it exists in our vessels to-day is, with very few exceptions, the same as the turbines of this type which were fitted in the initial turbine vessel, the *Chester.* The only improvements which have been made consist of changes in blade angles, particularly in the low-pressure stages, an increase in the number of rows of blades in these same stages, and the fitting of nozzles for the admission of auxiliary exhaust steam at several different locations along the steam path.

With the impulse turbine, however, the advance over the original naval turbines of this type, those of the scout *Salem,* has been rapid. The number of stages has been very much increased, both in battleship and in destroyer turbines, a drum construction has been adopted for the lower-pressure stages, steam balance for propeller thrusts has been provided, cruising nozzles for low fractional powers have been fitted, and nozzles for utilization of auxiliary exhaust are now supplied as in the Parsons turbines.

That these changes in turbines of the impulse type have been accompanied by increase in economy has been thoroughly demonstrated by experience with the machinery of the destroyers, the economy of the impulse turbine showing up nearly, if not fully, as good as that of the reaction type. No opportunity has as yet been offered to obtain a measure of this economy increase with the battleship types of impulse turbine, nor will such opportunity occur until the *Nevada* is ready for trial.

Improvements in Reciprocating Engines Tending Towards Increased Economy and Reduction in Weight

The steps taken in pursuit of the above objects are:

1. Increase in steam pressure at engine.
2. Change in design of engine framing.
3. Increase in piston speed.
4. Use of superheat, but to a small degree only.
5. Reduction of clearances in cylinders.
6. Decrease of frictional losses through steam ports.
7. Positive circulation of steam through steam jackets.
8. Reduced back pressure in low-pressure cylinders.
9. Increased ratio between low-pressure and high-pressure cylinders, with consequent increased ratio of expansion of steam.
10. Application of forced lubrication to all journals, crosshead guides, eccentrics and thrust bearings.

While the following improvements, both with reciprocating engines and with turbines, have been made:

11. Improved condensing apparatus resulting in higher vacuum.
12. Rational designs of feed heaters based upon amount of water to be heated and amount of auxiliary exhaust steam available for heating purposes instead of using the old rule of thumb of allowing a fixed number of horsepowers per square foot of heating surface.
13. Basing steam-pipe design upon actual rate of flow of steam through the pipes as determined by tests in service.
14. Reduction of feed-pipe losses to a minimum.
15. Improved evaporators and other auxiliaries.

In addition to the above, the reliability of the machinery plant has been improved by

16. Adoption of high-speed, electric-driven forced-draft fans for battleships.
17. Turbine-driven forced-draft fans for destroyers, and the most important of all,
18. The adoption of oil fuel for both battleships and destroyers.

Considering the above changes in detail, the steam pressures at the main engines since 1895 have been increased

gradually from 150 pounds per gage to 265 pounds per gage in the high-pressure valve chest, resulting in decreased size of engine cylinders and in decreased size of steam piping for equal units of power.

The engine framing of the vertical engines first fitted was either of cast steel or built up of steel plates. On several vessels trouble has been experienced with this type of framing, particularly when made of cast steel, and, in addition, the weight was high. The Bureau of Steam Engineering, in order to overcome these faults, designed and adopted a built-up framing of forged steel for the *Kearsarge* and *Kentucky,* and this style of forged steel, built-up framing has been adhered to.

Since the adoption of this type of framing, framing troubles are unknown, notwithstanding the fact that the weight of the modern framing per indicated horsepower has been reduced to about 3.3 pounds against 5½ pounds for the old.

Since the design of engines for the *Oregon* were laid down, there has been a gradual increase in piston speeds used, from 900 feet in that class to 1,000 feet in the *Delaware* class. This increase in piston speed has been followed by decrease in weight of the moving parts and has aided in holding down the weight and height of the engine, although the stroke has been increased from 42 inches to 48 inches.

In the use of superheated steam, the Bureau of Steam Engineering has been rather conservative; at present there are seven vessels in the naval service fitted for superheat, the maximum degree of superheat obtained at the boilers being 85° F., which reduces to about 60° F. at the engines. These figures are for full-power conditions, and an increase in economy of about 6 percent is estimated to be obtained. At 12 knots, the cruising speed, the saving by the use of superheat hardly exceeds 3 percent.

The first experiences with the vessels fitted with superheat were far from satisfactory, due to the rapid deterioration of the valves in the steam lines. These valves had cast-steel bodies and cast-steel valve disks with monel metal seats. The erosion and corrosion of the valve disks was very extensive, and in a short period of service it became necessary to replace the cast-steel valve disks with disks of monel metal. This substitution has been satisfactory and no further trouble has been experienced.

The superheat has been used only on battleships fitted with reciprocating engines or impulse turbines for propelling purposes and has not as yet been used on any of the destroyers.

Reduction of clearances, decrease of frictional resistances of steam through the steam ports and reduced back pressures in the low-pressure cylinders have all resulted from one very important change in the design of engine cylinders and valve chests by substituting for the long-tortuous port a short direct port.

The result obtained by this change can best be shown by the following table of comparison of cylinder clearances and steam velocities:

	Old Type.	New No. 1.	New No. 2.	New No. 3.
Diameter of cylinders, inches:				
H. P.	32½	38½	32	35
I. P.	53	57	52	59
L. P.	2—61	2—76	2—72	2—78
Stroke of pistons	48	48	48	48
Percent clearances:				
H. P.	28	16.17	13.83	13
I. P.	20.8	13.17	12.65	13½
L. P.	18.5	12.485	12.02	12
Steam velocity, feet per minute:				
H. P.	5,670	6,565	6,723	6,402
I. P.	8,262	6,678	7,883	7,517
L. P.	10,833	10,446	9,947	10,281
Exhaust velocity:				
H. P.	5,480	5,340	5,289	5,078
I. P.	6,670	6,180	5,909	6,087
L. P.	7,450	7,514	7,199	7,298
To condenser	7,390	6,937	6,612	6,500

In the last ten years the cylinder ratio of low-pressure to high-pressure, for triple expansion engines, has been increased from about 7 : 1 to 10 : 1, including clearances. This increase in ratio had been used previously in remodeling the engines of the *Cincinnati* and *Raleigh,* with most excellent results. A serious mistake was made, however, in counting too much on the increased expansions obtained by fitting a smaller high-pressure cylinder than that originally installed, the steam pressure having been increased. The new high-pressure cylinder was made 24 inches in diameter and the ratio of low-pressure to high-pressure cylinder changed to about 11½ to 1. While the economy obtained with these engines was most excellent, the high-pressure cylinders were entirely too small and the engines have never developed the expected power.

By the adoption of forced lubrication for the main propelling engines, the engine friction has been enormously reduced. All the journals are oil borne, so that no metal to metal contact occurs. The result has been that the amount of adjustment and overhaul of the main engines has been decreased to a very large extent, and the men who would have been used for this overhaul work can now be used on the auxiliary machinery to good advantage. This decrease in wear of the bearings, and the cushion provided by the oil, has resulted in a much better maintenance of alignment of the engines, has reduced shocks on the machinery and has reduced vibration due to these shocks.

In addition, there is considerable saving in oil at ordinary speeds. At high speeds there still exists a heavy loss of oil, due to splashing on the cylinder heads and also to loss by evaporation from the hot surface of the lower heads.

When first fitted, the forced lubrication gave trouble, due to oil being drawn through the low-pressure piston-rod stuffing boxes. In order to remedy this defect, stuffing boxes fitted with steam seals have been supplied, and later reports indicate that where the steam seal is properly fitted no trouble of this kind now exists.

That the foregoing changes have produced great economy is amply demonstrated by the results obtained with the machinery installations of the *Michigan, South Carolina* and *Delaware.*

With the advent of the turbine for marine propulsion, if the full benefit of the new machine was to be realized, a high vacuum in the condensers became imperative. In order to obtain such vacuums, the Parsons Company originated the vacuum augmentor, and this addition to the condensing plant is used extensively in the naval service. In some vessels in the service, in place of the ordinary air pump with augmentor, air pumps of the dual type, as manufactured by Weir, have been fitted, while in other vessels both wet and dry air pumps have been used.

Of these systems, that with augmentors and also the dual type appear to give the greatest satisfaction in service, and in addition require less weight and space than the wet and dry system. Abroad, a new system, known as the "Kinetic," has been developed, and all reports received concerning it have been very favorable, but no example of this system yet exists in the American naval service. In conjunction with these improved systems has occurred an improvement in the tube spacing and the baffling of the condensers in order that a better separation of air from the water of condensation will occur in the condensers.

The improvements in design of feed heaters, steam pipes and feed pipes naturally followed on the measurements of water consumptions of the machinery taken during the acceptance trials of the vessels. These measurements placed in the hands of the Bureau of Steam Engineering data of great value, and that bureau has attempted to use the full value of it in proportioning these important items.

For instance, the feed heaters of the Delaware were, for lack of data, proportioned on the basis of so many indicated

horsepower per square foot of heating surface, and the two heaters combined have a total heating surface of 2,100 square feet. In her sister ship, the *Utah*, the same degree of feed heating is obtained with heaters having a total surface of only 512 square feet.

In the search for economy, the Bureau of Steam Engineering has adhered strenuously to the use of feed heaters with auxiliary exhaust steam as the heating medium, using any excess of exhaust in the low-pressure turbines or the second receivers of triple expansion reciprocating engines. This utilization of the auxiliary exhaust has not been to the taste of the turbine manufacturers who prefer to use all of this steam in the turbines, depending for feed heat upon that derived from steam drains discharging into the feed tanks.

The improvements in evaporators consist mainly in the adoption of double effect connecting and in throwing open the gates to other than the standard bureau design, although these are not the only changes from former practice. Evaporator feed heaters using the vapor from the evaporators as a heating medium have been fitted, and vapor pipes, better designed for the amount they have to carry, are installed.

Until the adoption of electric-driven blowers for battleships and other large vessels and of turbine-driven blowers for destroyers and small vessels, the successful outcome of any heavy forced-draft run was always endangered by the unreliability of the blowers. Since the adoption of these types of blowers this danger of breakdown has been almost entirely eliminated, and, so far as the destroyers are concerned, the blowers may be classed as one of the most, if not the most, reliable of the auxiliaries fitted.

Oil Fuel for Destroyers and Battleships

In deciding to adopt oil fuel for use on battleships and destroyers, the Navy Department took into account the following advantages which would be gained by its adoption:

1. Less fuel required for any given radius of action, consequently less percentage of displacement and less bunker capacity required for the fuel.
2. Increased boiler efficiencies.
3. Decreased fire-room force.
4. Less deterioration of boilers due to maintenance of more even temperatures.
5. Ability to maintain high powers for indefinite periods.
6. Less deterioration of ship's structure due to there being no water or ashes in the bilges.
7. Greater cleanliness.
8. Greater ease in replenishing fuel supply, both in port and at sea.
9. Less floor space required for the development of a given power.
10. Greater ease in control of steam supply.

In opposition to these undoubted advantages the following disadvantages exist:

1. Fuel oil less widely distributed over the earth than coal.
2. Greater unit cost than coal.
3. Greater danger of fire than with coal.

The reply to the first disadvantage is that in time of war a fleet operating far from a base would depend upon fuel ships for replenishing her bunkers, and that oil can be carried in bulk as well as coal, and bases where stores of oil can be kept on hand are as easily established as are bases for coal, and such oil bases would have, in case of danger of capture by an enemy, the additional advantage of being much more readily destroyed, together with their stores of fuel, than are coal bases.

The second disadvantage, that of excess cost over coal, is more than compensated for by the quoted advantages.

The third disadvantage, that of danger from fire, is very thoroughly guarded against by storing the oil in compartments remote from the boiler rooms, and situated well below the waterline of the vessel. In addition to these primary precautions, additional safeguards are provided which render the danger from fire fully as remote as the danger from magazine explosions.

Upon deciding on the adoption of oil as a fuel for the naval service, the Bureau of Steam Engineering examined carefully all the systems for burning oil that now exist and finally decided upon that of mechanical atomization of the oil as the one most suitable for naval use.

In this system, the oil is pumped through heaters to the burners, within which it is given a whirling motion. The small central core of oil, discharging through the tip orifice with this whirling motion, the oil flies off and forms a cone of fine mist. This oil mist mixes thoroughly in the furnace with air which passes into the furnace through a cone register surrounding the burner, the register having adjustable openings and guide vanes so that the amount of air to each burner may be regulated and the direction of flow of this air be slightly oblique to the axis of the cone of oil.

The success of the system depends almost entirely upon the proper handling of the air. Improper air regulation will produce a series of rapid explosions of oil in the furnaces with consequent destruction of the brick linings of the furnaces. With proper handling, the oil burns almost noiselessly, and the amount of smoke produced can be held absolutely under control.

In the first battleships fitted with oil fuel, the oil was only fitted as an auxiliary fuel and was intended to be used as an aid in keeping up steam when the coal should be so low as to be remote from the fire-rooms and so require excessive trimming. The results obtained with this mixed system are not to be rated as good nor were good results expected, as the furnace volumes of coal-burning are too small to permit efficient burning of oil. Furthermore, when burning the oil and coal in combination it is impossible to so regulate the air supply that each fuel will obtain the proper amount. This results in excessive production of smoke and no increase in steam production over coal alone.

Conclusion

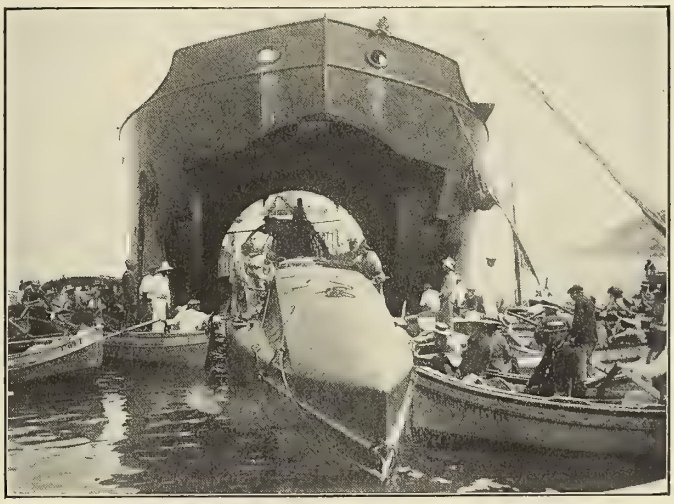
With such a large field to cover as suggested by the title of this article, the limitations as to length of the article prohibit anything more than a brief discussion of each point considered, but it is hoped that what has been presented will assure the Society of Naval Architects and Marine Engineers that engineering progress in the naval service has not ceased, and that the Bureau of Steam Engineering, greatly assisted by its co-workers in the development of the navy—that is, the other technical bureaus of the Navy Department and the engineers of the various shipbuilding yards engaged in naval work—is to-day at least as progressive and as free from ultra conservatism as it has ever been in its history.

New German Shipping Rules.—New rules for ocean-going steamships were approved on Oct. 28 at a conference held at the German Ministry of the Interior, at which representatives of the German Ministries, the Federal Council and the shipping interests were present. The new rules deal with the questions of bulkheads, lifeboats, wireless telegraphy and the reporting of icebergs. All passenger steamers carrying 75 persons, including the crew, and freighters carrying a crew of 60, must in the future be equipped with wireless telegraphy having a radius of 100 sea miles, and these vessels must carry a certain proportion of skilled oarsmen to man the lifeboats. The existing regulations as to bulkheads have also been thoroughly revised.

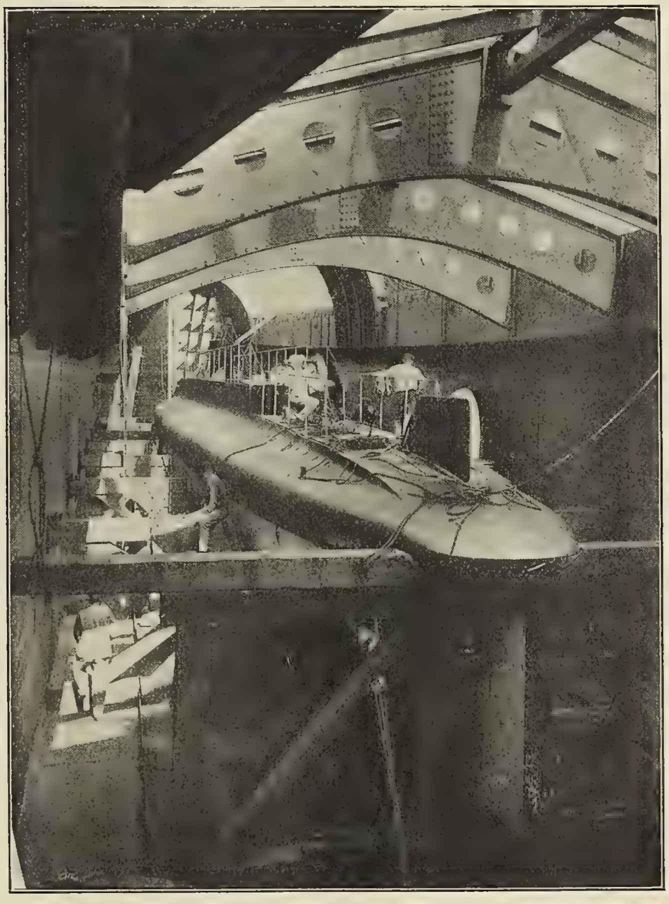
GENERAL VIEW OF THE KANGUROO WITH OPENING AT THE BOW FREE

Transport Ship for Submarines

The illustrations on this page give different views of the transport ship *Kanguroo,* built by the Société Anonyme des Chantiers et Ateliers de la Gironde, Bordeaux, France, for Messrs. Schneider & Company, of Creusot, for the transportation of submarine boats on long sea voyages. The *Kanguroo* was described on page 353 of our September number. The accompanying illustrations, however, give a better idea of the method by which the submarine is placed on board the ship for transportation. For this purpose the vessel virtually becomes a floating dry dock, the forward part of the ship is afterwards closed and the vessel becomes an ordinary cargo boat.



THE SUBMERSIBLE ENTERING STERN FIRST



THE SUBMERSIBLE SHORED UP READY FOR TRANSPORT

THE SUBMERSIBLE AFLOAT IN THE KANGUROO

Notes on Fuel Economy as Influenced by Ship Design*

BY E. H. RIGG

In recent years we have witnessed great progress in marine engineering; new types are striving for first place, each having its advantages and its advocates; geared turbines, oil and gas engines, electric transmission and other schemes, each offering economies of fuel and therefore lesser operating expenses.

The latest transactions of the technical societies concerned all contain papers bearing on the subject, especially the one read before the Northeast Coast Institution last April and the one on the geared turbines on the channel steamer *Normannia,* read before the Institution of Naval Architects this year, to say nothing of many important papers read elsewhere.

These all point out the possibilities of ecenomy from the point of view of machinery savings. It is the object of these notes to point out possible economies due to efficient ship design, because savings are being made by naval architects, as well as by marine engineers.

Cheapness of operation is one of the necessities for commercial success in a competitive age. The problem of evolving economical ship forms is an intricate one, and a study of the records of this society will show that much time and money have been spent in the pursuit of efficient forms, which is another way of saying economy.

Experimental tanks have been built in all the leading maritime countries, and commerce is slowly but surely beginning to reap the benefits. Not only has ship form come in for the attention it deserves, but we have lately witnessed renewed efforts to solve propeller problems, so necessary to keep up with the higher speeds of revolution demanded by the new types of propelling machinery.

It is at once evident that the naval service has reaped the greatest benefit of the study devoted to ship propulsion; perhaps this is only natural, the pioneer experimental tank in our country being the government one at Washington. That this tank pays is evidenced by the difference between the *Connecticut* trials and those of the *Michigan.* The average ship of the *Connecticut* class required 15,700 indicated horsepower for 18 knots, whereas the later design, of identical displacement and type of machinery, required only 13,100 indicated horsepower for the same speed. This means that for 10,000 miles the saving in coal amounts to some 1,100 tons at 18 knots; this can be fairly credited to the experimental tank and its able staff.

Our destroyer designs are also good examples of efficient propulsion; the way in which the recent vessels have gone through their trials compared with those of twelve years ago needs no comment.

The best speed at which to run a merchant vessel is not a question that the builder has much to do with. The distance between ports, proportionate values of passenger and freight business, the nature of the cargo, mail-carrying requirements, character of the waters traversed, and the competition to be met are the prime factors in determining this speed. Once it has been decided upon, the builders should be allowed to settle the dimensions best suited to the speed and the work (passenger and freight accommodations) expected of the vessel. It is surprising how many vessels are run at unsuitable speeds, some unavoidably so on account of passenger accommodations; but the majority could well have been reconciled in the design stage as regards the dimensions, speed, capacity, stability, trim and deadweight.

* A paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1912.

When the owners decide on their real service speed, the builders should not be required to run a measured mile trial reaching a top speed out of all proportion to the service speed; it can only be done at a sacrifice of efficiency elsewhere, probably in the fining of the ship and consequent reduction in carrying capacity.

In fast passenger liners the proper reconciling of speed and dimensions may very well spell success or failure to the whole venture; this should be recognized and some time devoted to preliminary design work and model tank tests. The preliminary work on the *Mauretania* designs furnishes a case in point. Why should not corresponding care and attention be devoted to less ambitious designs? That many owners are seeking to get the maximum out of their investment is evident when we consider the number of special types lately coming to the front, all designed with a view to the utmost efficiency in their particular line, not only for driving but more especially for cargo handling and storage.

The following examples have been collected from recent experience in general design work, with the hope that others will be brought forward in discussion by those whose daily experience has been along similar lines.

Example No. 1

Advantage of model tank experiments on hull forms and of careful propeller design.

The data below can be vouched for, the two vessels being tried over the same course, Delaware Breakwater; both were deep load draft trials and progressive runs were made.

It will be noticed that the displacement of the larger vessel, the model of which was tried in the tank, is 46 percent in excess of the smaller, and the power identical at cargo vessel speeds. The larger vessel would take even less power at sea than the smaller on account of size. The first vessel is an oil tank and the second a United States naval collier of the *Mars* class.

The figures below speak for themselves:

Item.	Year of 1903.	Completion, 1909
Length	360 ft. 0 in.	385 ft. 0 in.
Breadth	46 ft. 3 in.	53 ft. 0 in.
Draft	20 ft. 7 in.	24 ft. 8 in.
Displacement in tons	7,700	11,260
Block coefficient	.786	.784
Propulsion, system of	Single screw	Twin screw
I. H. P. for 10 knots	1,525	1,550
I. H. P. for 11 knots	2,125	2,100
I. H. P. for 11½ knots	2,500	2,400
I. H. P. for 12 knots	....	2,800
Dead weight carried in tons	5,000	7,400

Example No. 2

An interesting case of extravagant design came up recently. A shipping firm had plans of an 11-knot steamer built in Europe of the following general dimensions: 400 feet by 52 feet by 34 feet. They wanted a duplicate built here, but with machinery for 10 knots only. The suggestion that the steel hull could be built 6 percent cheaper to modified dimensions without affecting the coal bill was rather a shock to the prospective owners. The vessel as redesigned, with identical deadweight, draft and cargo capacity, worked out at 370 feet by 54 feet 6 inches by 35 feet. The power worked out as follows:

Item.	400-Ft. Ship.	370-Ft. Ship.
Skin E. H. P.	685	645
Residuary E. H. P.	365	405
Total	1,050	1,050

These are for 10 knots in each case. In addition to less first

cost, the shorter boat will be handier at sea, more easily taken care of as regards stability, and occupy less space at piers. There was no question of repeating an order.

Example No. 3

In heavy bulk carriers it is desirable to know how full a vessel can be made, keeping capacity down and so having no more ship than is necessary. A majority of ship designs on this coast are prepared for light cargoes occupying large space, where ship dimensions run large per ton deadweight; hence the saving in ship dimensions possible when carrying ore, for instance, is apt to be overlooked.

These vessels are frequently run at only 9 knots, even though they have some margin of power; the problem resolves itself into one of finding the range of dimensions where the total resistance remains constant, even though the component parts vary. In a design to carry 7,000 tons deadweight it was found practicable to increase block coefficient from .75 to .78 and reduce length from 360 to 340 feet for the same effective horsepower at 9 knots; this represented a 5 percent saving in steel hull. Beam and draft remained constant.

This problem and the preceding one are merely examples of searching for the economical limit of speed, on which subject a good deal has been published from time to time.

While the temptation to keep power down by fining the ship is a strong one, especially when owners expect a very low coal per diem rate, ship designers should never allow the dimensions to run up beyond what this somewhat elusive economical limit requires.

Example No. 4

Quadruple expansion machinery versus triple for long voyages.

The author recently had a very forcible example of the saving possible if quadruple expansion machinery were fitted in a cargo steamer designed to carry 7,000 tons of paying freight for a distance of 14,000 miles, oil burning. The figures came out as follows:

Item.	Quadruple.	Triple.
Length	400 ft. 0 in.	410 ft. 0 in.
Breadth	53 ft. 0 in.	53 ft. 0 in.
Draft	27 ft. 0 in.	27 ft. 0 in.
Ship, tons	4,125	4,160
Cargo, tons	7,000	7,000
Oil, crew and water	1,900	2,200
Displacement	13,025	13,360
Speed, knots	11	11
I. H. P.	2,750	2,800
Savings per voyage	$2,500 (£510)	....
Extra first cost	$10,000 (£2,050)	....

It will be seen that the extra first cost is recovered in four voyages, and after that a steady gain per voyage is apparent. This is not strictly an example of economy due to ship form, but has been inserted as being perhaps of interest.

Example No. 5

From the point of view of economy due to machinery, it can be shown that single-screw propulsion is cheaper than twin screw, the advantage of twin screw being in greater immunity from breakdown, a point by no means negligible in passenger and perishable cargo ships. This is well known to the members of the Society, and is only mentioned to make the examples more complete.

Example No. 6

Recently published photographs of our latest battleships in dry dock reveal a peculiar bulbous form of bow, the load waterline being narrowed and the displacement made up by filling out the lower waterlines. Experiments at the model tank in Washington show a material saving due to this form, the bow waves being naturally lessened by the fine upper waterlines.

The superintendent of one of our coastwise lines of steamers has had the courage to adopt this form of bow for a 12-knot cargo steamer, in which a 3 percent saving would mean a ton of coal per diem, a by no means negligible amount when figured in dollars per annum. It is to be hoped this will be realized in service.

Example No. 7

It is well known that river steamers at certain speeds and in certain drafts of water create excessive waves, causing bad erosion of the banks, besides damage to shipping.

A firm of owners recently had conducted for them experiments with several models to see what could be done to reduce this wave under their operating conditions. The tank finally showed them the best lines on which to lay down the vessel for minimum wave-making, the speed being obtained with less power in addition. This also reduced the slowing up necessary to prevent damage to shipping along the banks. The top speed was obtained in deep, smooth water for less power with the model that gave best results in shoal water. The vessel is 410 feet long and of 8 feet draft.

In 20 feet of water a saving of some 5 percent resulted at working speeds. At low and moderate speeds up to about 18 knots, the best model for shoal water was the worst in deep water, but this could well be ignored in a river steamer.

Example No. 8

A sound steamer of wide beam relative to draft, having flared guards. The plans submitted for bids had a midship section which, while good for stability, seemed to be capable of considerable improvement from the point of view of the coal pile. Recognizing the necessity of keeping the same stability, a fuller midship section was designed. At the expense of 2 percent increase in the shell and framing of the vessel, an 18 percent saving can be made in the coal bill; in other words, the improved lines would cut the power from about 2,750 to 2,250, indicated, at 16 knots on a deep-water mile trial. The vessel was 270 feet long and of some 2,250 tons displacement.

Anyone who keeps up to date with the transactions of this and kindred societies will know what valuable original research work has been placed on record during the last few years. These notes make no claim to originality, but merely attempt to show, from the point of view of the practical designer of ships, the results presented in another form by our fellow designers working at experimental tanks and in colleges along more purely scientific lines than are possible at a shipyard, where the contract delivery date generally places a strict limit on the amount of preliminary investigation possible before the design has to take concrete form in the mold loft and the shops.

Tests of Corrugated Hulls.—Naval Constructor David W. Taylor, U. S. N., will conduct a series of tests on models of ships with corrugated sides at the Washington navy yard during this winter. Four merchant ships of this type have been built in England and proved successful. It is expected that the same idea might be applied to battleships with a marked saving in propulsive power. Two outward curves, 23 inches deep, run the length of the ship between the load waterline and the bilge. Between the convex curves is a concave surface of equal depth. This partial application of the tube principle greatly increases the strength of the hull as well as increasing the propulsive efficiency of the vessel.

An Electrically Propelled Fireproof Passenger Steamer*

BY WILLIAM T. DONNELLY AND GEORGE A. ORROK

The plans herewith submitted show a vessel 275 feet long over all, 260 feet on the waterline with an extreme beam of 68 feet and a molded breadth at the waterline of 45 feet 8 inches, designed to have a displacement of 1,714 tons on a draft of 10 feet. The hull is designed to have a double bottom for a length of 188 feet and double sides carried up to the deck for a length of 109 feet, corresponding to the machinery and boiler space. It is also intended to make the coal bunker space on each side of the boilers with semi-watertight doors, which will add a large additional factor of safety. The design provides for seven watertight bulkheads carried up to the deck and there is no provision for openings; that is, so-called watertight doors through bulkheads are to be entirely eliminated.

By referring to the general design elevation it will be seen that the vessel is to have three full decks and that the pilot-house and officers' quarters comprise a fourth.

The boiler space is divided by watertight bulkheads into two fire-rooms, and the boiler casing is carried up through the center of the superstructure. The engine-room space is also surrounded by steel housing in such a way as to prevent the possibility of steam escaping into the passenger space.

The superstructure and decks are to be built entirely of light steel, no wood being used except as a guard strip on the outside, and with this construction it will be practically impossible to start or maintain a fire in any part of the boat.

Attention is called to the detailed design for the steel deck, in which very light plates are used running across the vessel, with their edges flanged and united to steel carlins. The upper surface of the plating is to be covered with canvas, which makes a watertight and weather-proof joint where the plates meet. The carlins are to be supported by 6-inch steel I-beam stringers carried on steel pipe stanchions. It should be here mentioned that these steel pipe stanchions and steel stringers under carlins are now in use on the highest class of river passenger boats.

At the present time all steam engines are controlled by the engineering staff through signals from the pilot-house. In the case of the electrically-propelled steam vessel this double control, involving a signal between two parties, will be eliminated, the operating staff would deal solely with the production of the power, and the use and control of the power be centered in the hands of the executive officers of the ship, as it clearly should be. To this division of responsibility electricity lends itself in a marvelous way.

Granting the broad application of electric generation and propulsion to steamships, we have before us new conditions altogether unexpected and surprising. In the *Grand Republic*, a steamer in comparison with which the plans herewith are submitted, we have a vessel in use for not more than four months in the year. For the remaining eight months we have an investment totally incapable of any use. In the power plant of the steamer here shown we have a generating plant of 3,000 horsepower, which can deliver itself to any location on navigable water and deliver 3,000 horsepower in electric energy utilizable for any possible purpose, either for light or power, and if this system were to be applied to a freight steamer it is equally apparent that instead of the power plant of the steamer being useless when in port all the power would be available for handling cargo or for any other purpose.

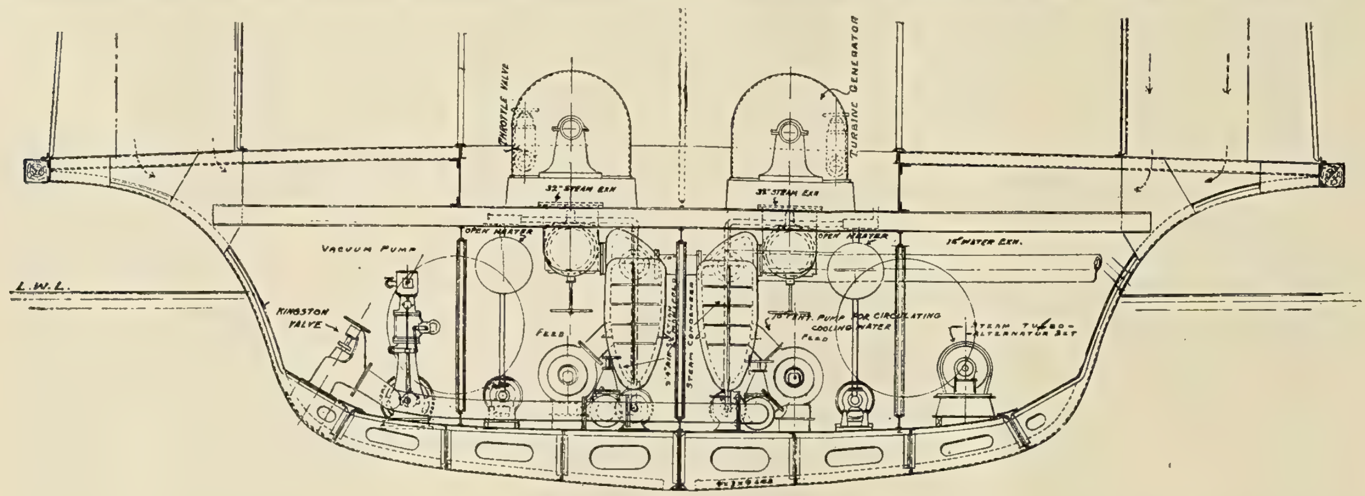


FIG. 1.—SECTION THROUGH ENGINE ROOM

The design of the machinery for the vessel whose plans are here presented has been treated from the viewpoint of the central station, the control of the motors driving the three shafts being in the pilot-house, making the load on the leads to the motors (corresponding to the load on the feeders) as independent of the generating apparatus as in a power station. The generating units are standard pieces of apparatus, generously proportioned for continuous service, which have been developed to meet the exacting conditions of central station lighting service. They are provided with an automatic oiling and water-cooling system and the various attachments which have been proved necessary to insure the required regularity of operation.

The two units, 1,500 kilowatts, 80 percent power factor, maximum rating, are located side by side on a specially constructed portion of the main deck in a glass enclosure where suitable ventilation may easily be secured for the generators. Each turbine has an exciter direct connected on the main shaft, and the exciter regulation is automatic in its character, only requiring attention during the starting and stopping of the unit. One 25-kilowatt, steam-turbine-driven, independent exciter is also installed for starting up and to furnish lighting for such times as the main units are not in operation.

Directly below the turbines are the condensers, each of 3,000

* From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1912.

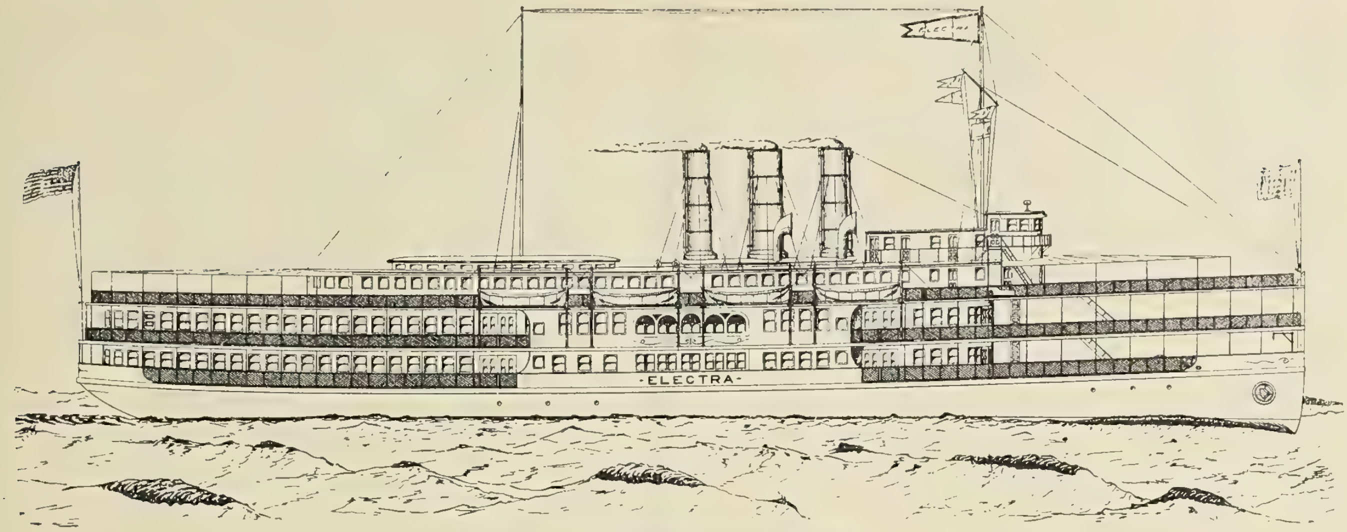


FIG. 2.—OUTBOARD PROFILE OF THE ELECTRA

square feet surface, with the other necessary auxiliaries, feed pumps, bilge and fire pumps, etc. The condensers are proportioned to maintain a 28-inch vacuum with the 70-degree water prevailing under summer conditions in New York harbor. The circulating pumps are turbine-driven, and under normal conditions will deliver 5,000 gallons per minute through the condensers.

The hot-well pumps are on the same shaft as the circulating pumps, and have a capacity of 150 gallons per minute against a head of 50 feet. These two pumps are of the centrifugal type and of standard design. In the wings on either side of the condensers are the two air compressors, which are also used for air pumps, and will, by a special device, discharge either at atmospheric pressure or at 10 pounds gage. Either unit, as

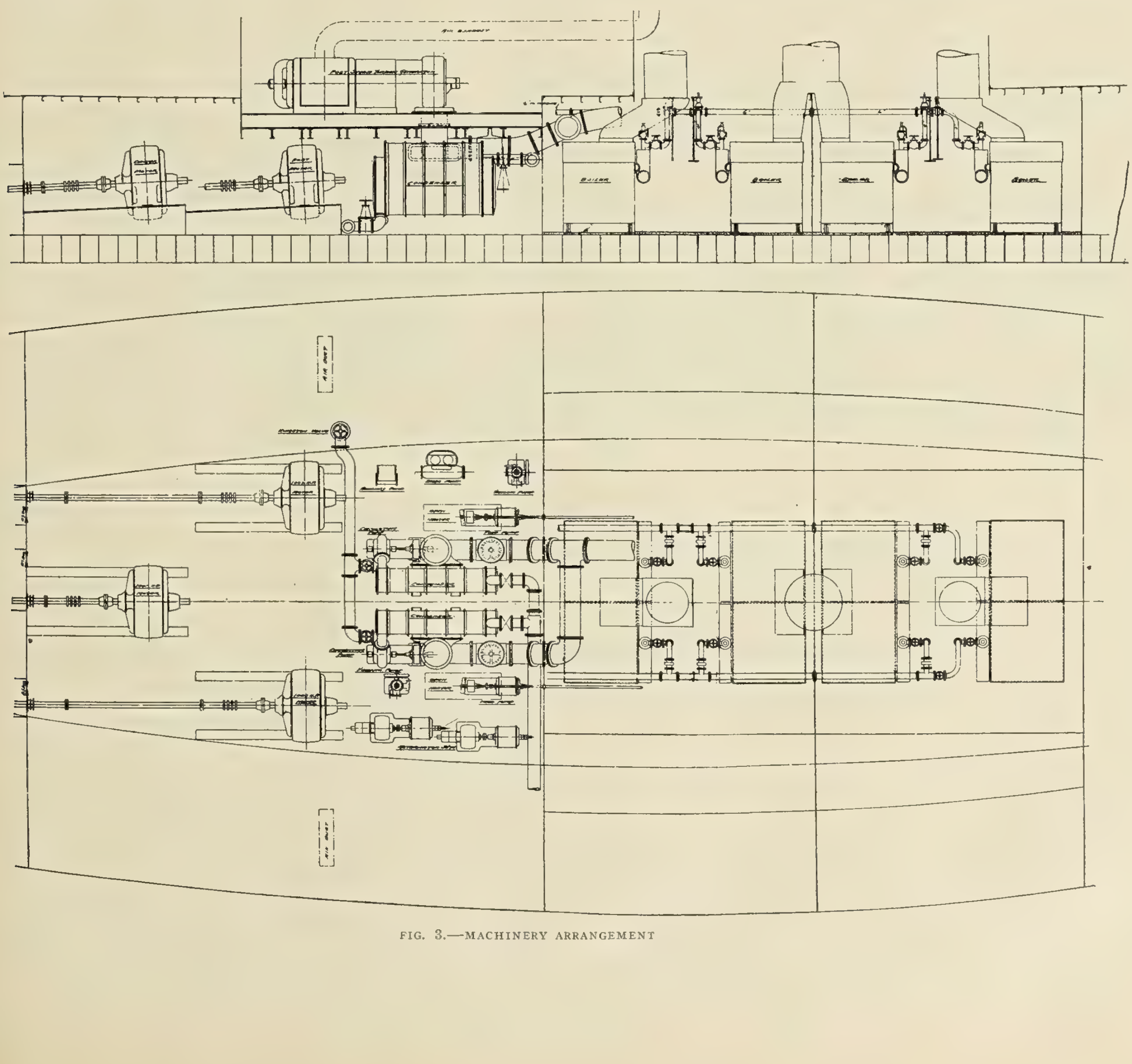


FIG. 3.—MACHINERY ARRANGEMENT

an air pump, has a capacity sufficient to handle both condensers, and the air suction pipes are interconnected.

The two turbine-driven centrifugal feed pumps are also located in the wings. Each pump has a capacity of 200 gallons of water per minute against a head of 700 feet, and one unit will be sufficient to feed the boilers except on special occasions. These pumps are run under nearly constant speed conditions, and are provided with an unloading device which by-passes the feed-water should the feed valves be entirely shut.

Two bilge and fire pumps are also provided, each of 150 gallons capacity, and a fresh-water tank pump of 50 gallons capacity for the make-up feed from the tanks. Above the feed pumps two open heaters, each of a capacity of 50,000 pounds of water per hour, serve to heat the feed-water by mixing with the exhaust steam from the auxiliaries. The turbine-driven auxiliaries have been proportioned to furnish about 90 percent of the steam required to heat the feed-water to 208 degrees F., and a live steam connection will be provided for the additional heat should its use be desirable. Suitable atmospheric exhaust connections and valves are provided, and the auxiliary exhaust has an oil separator in front of each heater, although but little oily steam will be present, as most of the auxiliaries are turbine driven. All of the small turbine bearings are ring-oiled and will require very little attention.

Immediately astern of the condensers and auxiliaries are the three 1,000-horsepower induction motors and the thrust bearings. These motors are very generously proportioned. They have 24 poles and a normal speed of 300 revolutions per minute. They are provided with collector rings and are controlled by means of varying the external resistance. The motors and generators are so designed that the current under a dead short circuit does not exceed two and one-half times the full-load current.

The controllers for the three motors are in the pilot-house, and are fitted with interlocking devices as well as an automatic timing device. All the motors may be started, brought to any speed up to full speed, reversed or stopped by the manipulation of the three controller handles, one for each motor. In addition, signaling devices are installed in both engine room and boiler room as well as the usual bell and speaking tubes.

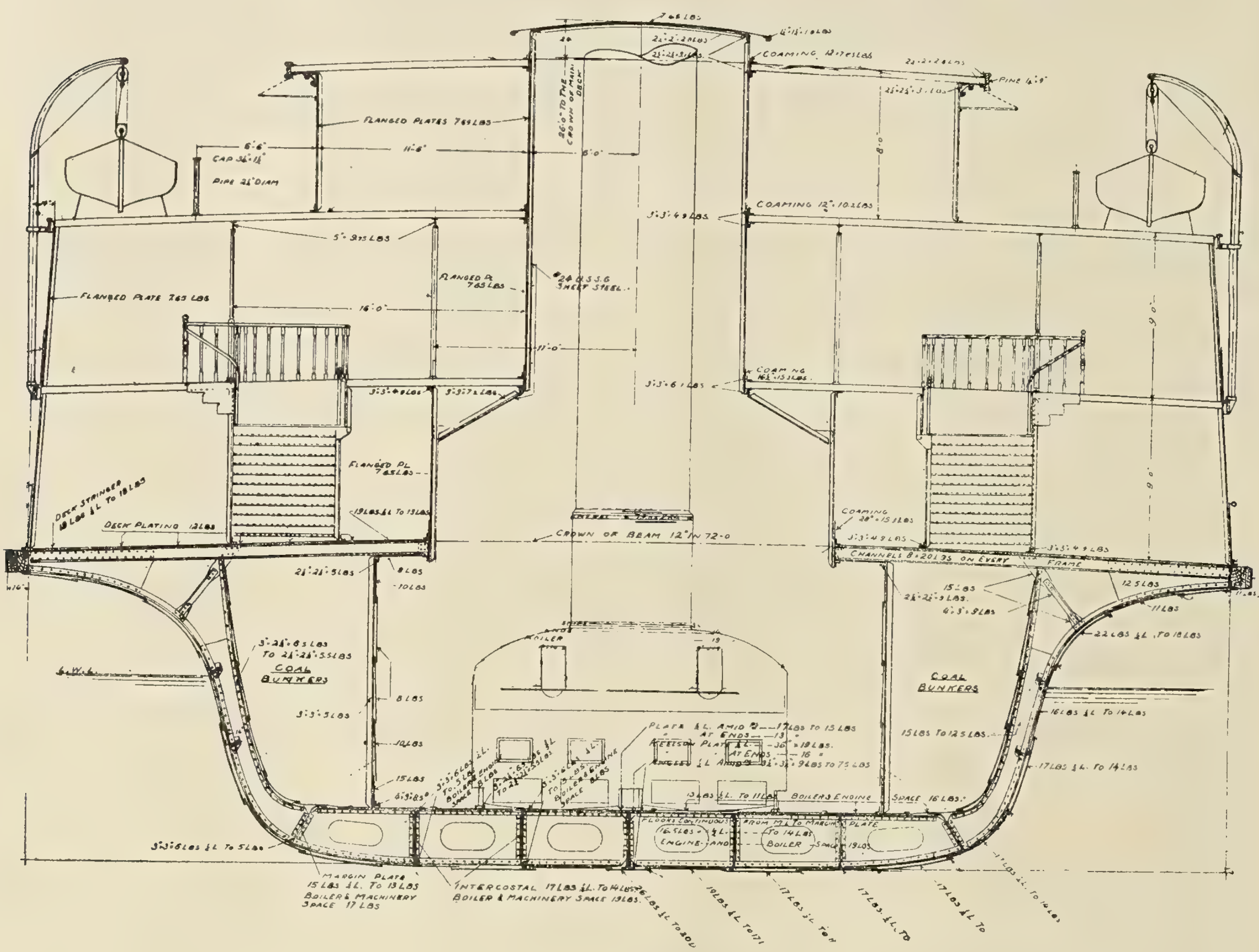


FIG. 4.—MIDSHIP SECTION

The fire-rooms, two in number, each containing four water-tube boilers in two batteries, are located forward of the machinery space. The coal bunkers are in the wings on either side of the batteries. Each boiler has 1,635 square feet of heating surface and 44 square feet of grate surface. The steam pressure will be 250 pounds gage, and the steam will be moderately superheated. The steam main is in duplicate with cross connections, as is the feed-water main, and both are of the highest grade. The steam piping is of steel pipe with Van Stone joints, steel flanges, fittings and valves. The feed piping is brass with brass valves and fittings. All boiler connections have two valves between the boiler and the pressure main, and the automatic stop-check valves usual in the best power-house practice will be installed. Each boiler is provided with steel, extra heavy safety valves of navy pattern.

The boilers are served by three stacks—one for the forward

pair, a large one for the middle four boilers, and one for the after pair. These stacks are 6 feet 6 inches and 8 feet in diameter and 72 feet above the grates. Forced draft has been provided for but the machinery will not be installed.

LIST OF MACHINERY

	Weight in Tons.
Eight water-tube boilers:	
Grate surface, 44 sq. ft. each..............352 sq. ft. total	
Heating surface, 1,635 sq. ft. each........13,080 sq. ft. total	105.0
Pressure ....250 pounds	
Main generating units:	
Two 3-phase, 60-cycle, 1,500-K. W. maximum 24-hour rating, 35 deg. C. rise, 3,600 R. P. M., 2,200 volts, 80 percent power factor	57.5
Three 1,000-horsepower induction motors, 24-pole, 300 R. P. M.	33.5
Three sets of switches and controllers	20.5
Two condensers, 3,000 sq. ft. cooling surface each; Two combination turbine-driven centrifugal pumps	25.0
Two independent exciter sets	3.0
Two turbine-driven centrifugal feed pumps, 200 gallons each	2.0
Two bilge and fire pumps, 150 gallons; Two tank pumps, 50 gallons	1.5
Two air compressors for 10 pounds pressure	4.0
Steam and other piping	5.0
Two open heaters, 50,000 pounds per hour	2.0
Three propeller shafts	11.5
Three propellers	3.0
Steel foundation for supporting machinery	25.0
Total weight of machinery	298.5

All auxiliary machinery is in duplicate, and, as far as possible, turbine-driven units are used.

The total weight of the machinery, including propellers, shafting, auxiliaries, switchboard, boilers, piping and water in boilers and condensers will probably not exceed 300 tons. This figure includes the steel seatings for the generating units and motors. Considering an equivalent of over 3,000 indicated horsepower in the motors, the weight of machinery is approximately .1 ton per indicated horsepower.

Besides the saving in deck space, in this case about 4,000 square feet, by the substitution of screw propulsion for paddle-wheels, the saving in weight over the vertical beam engine type with return tubular boilers is much more marked, as the average of a number of these boats gives for the machinery weights a figure of between .20 and .25 ton per indicated horsepower.

The coal consumption of vessels of the type of the *Grand Republic* is not far from 3.25 pounds per indicated horsepower under test conditions. With the ordinary running it would necessarily be larger. The vessel here described should, under test, give results approaching 1.5 pounds of coal per indicated horsepower-hour, and under ordinary operating conditions the saving in coal alone would probably amount to about 2 pounds per indicated horsepower-hour.

Allowing steaming time of ten hours at full power per day for 100 days, corresponding to the summer excursion season, the saving in coal would amount to 3,000 tons, which at $3.00 (12/6) per ton would mean a saving of $9,000 (£1,850), and this amount, capitalized at 10 percent, would warrant an additional investment of $90,000 (£18,500), which, it is believed, would more than cover the difference between the cost of the present type of boat and the one here presented.

Besides this saving in fuel there would be an additional economy in the matter of oil and general maintenance charges incidental to operating marine engines.

Super-Dreadnought New York Launched

The United States battleship *New York*, which is of the super-dreadnought type, was successfully launched Oct. 30 at the New York navy yard, Brooklyn, N. Y., in the presence of many distinguished guests, including the President of the United States, the Secretary of the Navy, the Governor of New York State and his staff, numerous officers of both the army and the navy, and many other persons prominent in the political and financial life of America. The launching weight of the hull was about 10,000 tons, and the vessel was released by a system of hydraulic triggers. The *New York*, like her sister ship, the *Texas*, which was launched May 18 by the Newport News Shipbuilding & Drydock Company, Newport News, Va., is 565 feet long on the waterline, 95 feet 2⅝ inches beam, extreme, 28 feet 6 inches mean draft, with a mean trial displacement of 27,000 tons and a full-load displacement of 28,367 tons. The vessel is designed for a speed of 21 knots, power being delivered to twin screws by two sets of triple-expansion reciprocating engines aggregating 28,100 indicated horsepower. Steam is furnished by fourteen Babcock & Wilcox watertube boilers, located in four separate boiler rooms. The total bunker capacity is 2,850 tons. The main battery consists of ten 14-inch, 45-caliber rifles, mounted in five twin turrets located on the center line of the ship. There are four 21-inch submerged torpedo tubes, twenty-one 5-inch rapid-fire guns, four 3-pounder saluting guns, two 1-pounder semi-automatic guns for boats, two 3-inch field pieces and two machine guns. The hull is heavily armored, the belt armor being 12 inches thick amidships. The turrets are protected by 14-inch armor. Tockolith, a special cement paint, is used to protect the under-water hull from deterioration.

LAUNCH OF THE UNITED STATES BATTLESHIP NEW YORK

Salvage Dock for Submarines

On March 11 a new salvage dock for submarines was delivered to the French Admiralty by her builders, the Ateliers & Chantiers de la Loire. She left St. Nazaire for Toulon, her home port, which is the home port of the Mediterranean French submarine fleet, and the place where many of these boats were built. The dock was towed to its destination by two powerful tugs, convoyed by a third steamer carrying the necessary supply of coal and provisions. The main dimensions of the dock are as follows:

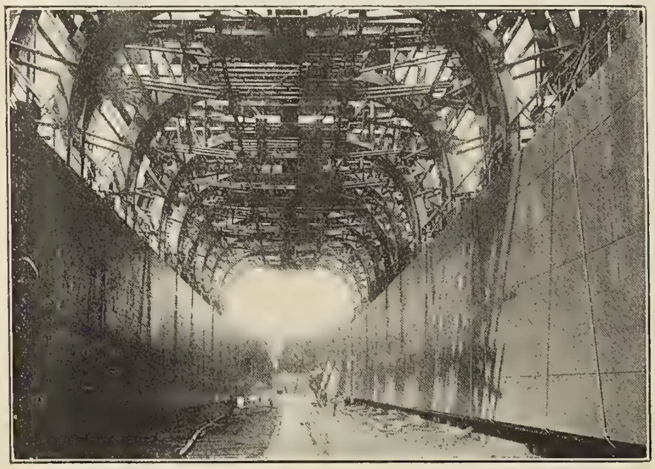
Length over all	322 feet 10 inches.
Main breadth	84 feet.
Breadth of each of the floating pontoons	20 feet 8 inches.
Depth	26 feet 3 inches.
Draft with coal and provisions	7 feet 8 inches.
Draft with a load of 1,000 tons	11 feet.
Displacement	2,300 tons.

The dock consists of two hulls or pontoons, joined together with ten steel frame girders, leaving a space 40 feet wide between the inside plating of the two hulls. Forward, these two pontoons are connected together, giving the bow the appearance of an ordinary tramp steamer. The two pontoons have been designed not only for maximum strength, but also for maximum stability, which is indispensable in salvage work. The starboard and port pontoons are exactly alike. The inside bulkheads are vertical plane surfaces, while the outside shell is built on the lines of a large lighter. The bottom is flat, and amidships the sides are nearly vertical, but towards the stem the lines become somewhat sharp, and at the stern they are very fine.

On each of the ten transverse girders are two tackles, one on the starboard side, the other on the port side, which are used for supporting the hull of the submarine. Each tackle is operated in connection with a hydraulic jack, which is used for making the strain uniform on all of the tackles, so that the tackles can be placed in operation either all at the same time or some of them independently. The power for this work is obtained from two electric generators having a total power of 150 kilowatts. Each tackle is tested individually for a load of 75 tons, making the total lifting power for the twenty tackles 1,500 tons. All that this apparatus is designed to lift, however, is 1,000 tons, so there is an ample factor of safety in the apparatus.

The power plant, which is located forward, consists of a Niclausse watertube boiler of 1,290 square feet heating surface.

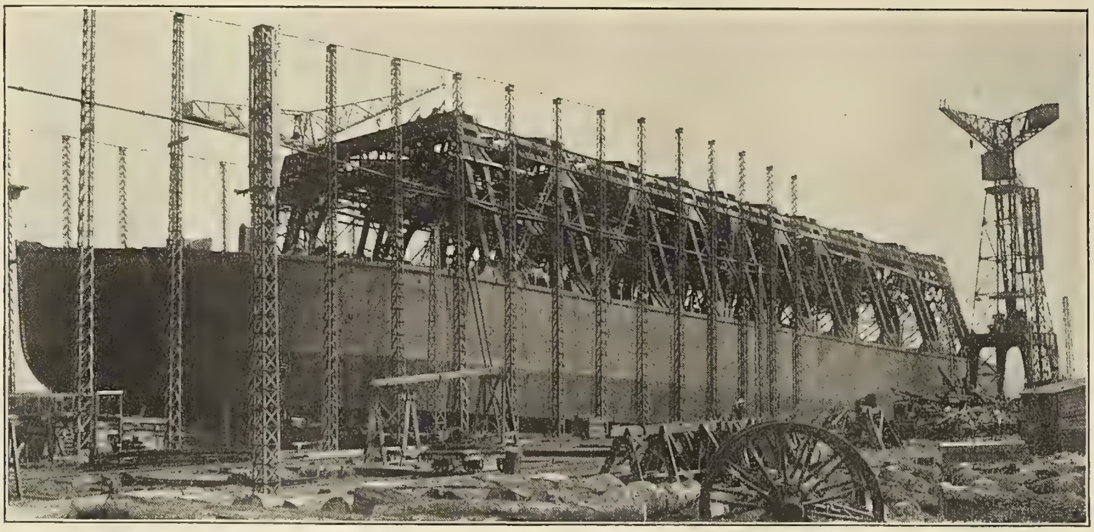
The two pontoons, as well as the forward part of the ship, are divided by numerous longitudinal and transverse watertight bulkheads. In the bottom there are water ballast tanks having a total capacity of 200 tons, which are used to obtain the best trim available under whatever circumstances may exist. There are accommodations for a crew of twenty in the forward part of the ship.



SALVAGE DOCK—FROM STERN LOOKING FORWARD

As compared with the German submarine salvage ship, the *Vulcan,* the new French salvage dock has no self-propelling machinery. It is reported that the German ship is able to steam at a speed of 12 knots under favorable conditions of weather. On the other hand, in bad weather the French dock will be difficult to maneuver, and since, as a rule, submarines get into trouble on the coasts, it is expected that this dock will have some difficulty in working in such surroundings, under the control of tugs, unless the weather conditions are ideal.

Owing to the fact that the French dock has a very small draft, even with a load of 1,000 tons, she can be used successfully in shallow water, which is important for the salvage of submarines. The machinery on this dock was built in the Nantes Works and the hull in the St. Nazaire yard.



FRENCH SALVAGE BOAT FOR SUBMARINES

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

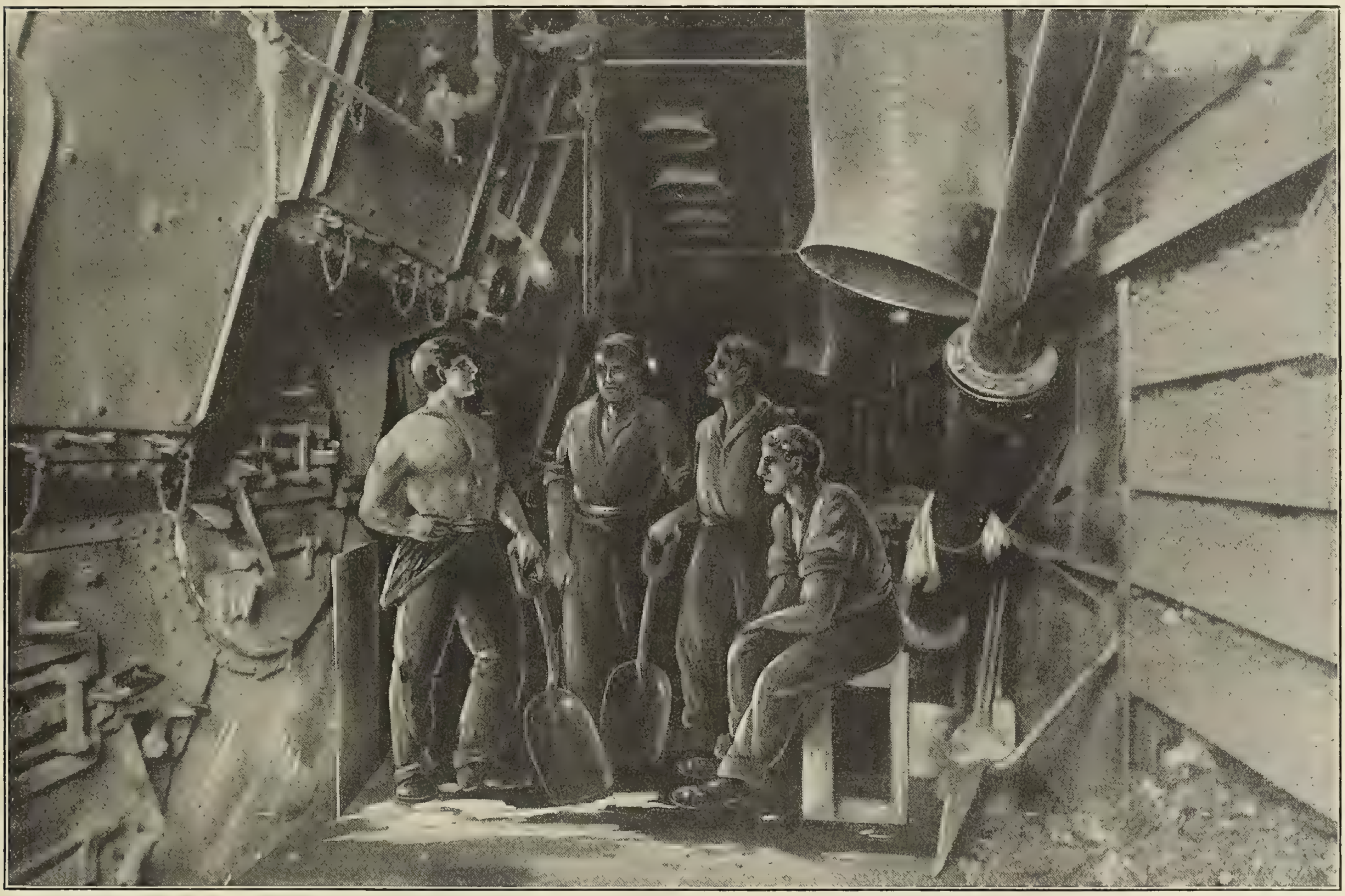
CHAPTER I

Introducing James Donald McAndrew

"I'm tired of shoveling coal and being bossed around," remarked Tom O'Rourke, one of a party of four husky young fellows who, at the end of a voyage, were just banking the fires in the stokehold on board the coasting steamer *Tuscarora,* then lying at her pier on the East River. This remark brought about a general laugh from the other members of the party. "Well," replied Jim Pierce, after the laugh had subsided, "what are you going to do about it? That's just what I've been thinking pretty strongly about; here I've been three years on this packet, working like a dog, and I don't see any chance of my ever getting anything better to do; of course, after a while, I may get a chance to squirt oil on that old mill of ours, but what I want to do is to get a 'ticket' and boss the job myself."

"Well, why don't you," rejoined Henry Nelson, another member of the party. "The Chief told me the other day that he had worked himself up from the bunkers, and he's pretty good at figures, too. If we only had the head on us that he has, we needn't wait long before the steamboat inspectors would pass us out the right kind of a paper."

Gus Schmidt, the fourth member of the party, had, during all this conversation, stood by quietly, drawing great puffs of smoke out of his five-cent meerschaum, and taking in everything that was said. As became his German ancestry, he was stolid of disposition and not given to saying much unless he had something to say. Finally, after he thought it was his turn to get into the conversation, he said: "You fellows make me tired with all your pipe dreams; why don't you get down to business; now I'll tell you what let's do. I just heard the 'Super' on the dock say to-day that the bunch of kettles in this ship are to come out, that we are going around to Philadelphia to get some new ones, and the ship is to be given a general overhauling at the same time, so as to put her in good shape for the next season's work. The Chief is going to boss the repairs, and the four of us are going to be kept by to chip and paint the coal bunkers and do some other high-class stunts like that. The whole job will last about six months, and as we won't have anything particular to do at night, let's buy some books and get the 'old man' to play school teacher for us."



"LET'S BUY SOME BOOKS AND GET THE 'OLD MAN' TO PLAY SCHOOL TEACHER FOR US"

"Fine business, Dutchy," said O'Rourke; "you've got a head on you like a clock. We'll go to it." The idea also met the approval of the other two, and it was decided to brace the genial Chief with the proposition.

James Donald McAndrew was a young man, not of French descent, as you no doubt may have surmised by this time, who was born on the great East Side in New York some thirty-eight years ago. Educated in the public schools until he was fourteen, he had successfully served an apprenticeship in a

* Engineer-in-Chief, U. S. Revenue Cutter Service.

big general repair shop on the waterfront, and at the same time had gone to night school at Cooper Union, where, being naturally bright, he had become thoroughly grounded in the rudiments of an engineering education. Being fond of the water, he had shipped on board a twenty-five hundred ton steamer as a fireman, and in a very short time had taken out his license as a Third Assistant. Being naturally a hustler and capable of making friends among his superior officers, he found himself at the age of thirty-eight the Chief Engineer on the *Tuscarora*, the biggest ship of the line. It was therefore quite in keeping that the Superintendent should have selected him as inspector of the extensive repairs the ship was about to undergo. Unlike many young men of his age who lead a seafaring existence, he took life somewhat seriously and had gone through the trying years of his development without falling into any bad habits. His father had died when the young man had just started in as a Third Assistant, which left upon him the responsibility of looking after his widowed mother and two young sisters. Consequently he was not given to wasting his money and could be found generally attending strictly to his business instead of roaming around town at nights when the ship was in port. His kindly disposition, ready wit and general all-around ability had won for him the respect of the crew, so he was not at all surprised this particular evening upon opening his stateroom door in response to a knock to find four members of the fireroom gang, hats in their hands, standing on the outside. "Well, boys, what can I do for you?" was his cheerful salutation.

O'Rourke, the self-constituted spokesman of the party, blurted out: "You see, Chief, it's this way; us four youngsters have an idea that we would like to get ahead in the world, and there don't seem to be much of a show for us if we don't get something in our heads. Dutchy Schmidt here thinks that if we will get some books, you might help us out when we get around to Philadelphia this winter putting in the new boilers. We'll have every night in, and as we will all live on the ship, we thought as how you might teach us something for an hour or so every night. We'll make it all right with you for the time you give us. What we want is to be able to get out our 'tickets' from the steamboat inspectors, and we know that you can give us the right steer."

"So you want to make me a school teacher, eh?" laughingly rejoined McAndrew. "That isn't a bad idea, though, and if you fellows mean business and will get right down to brass tacks I might consider it. I want to tell you one thing right now, and that is if I do undertake such a job I don't want any monkey business. You'll have to study hard or you'll find me worse than any old Yankee schoolmaster you ever dreamed of. Before I sign up on this proposition I want to know something about each of you. Of course I know you are all pretty good firemen and 'tend to business, but what I must find out from each of you is something about how much of an education you have. I know you are not graduates of a high school or you wouldn't be here flirting with a slice-bar and wrestling with clinkers for a living. O'Rourke, let's hear your spiel first."

"Well, sir," replied that worthy, "I ain't much on book learning, but I can write pretty well, understand arithmetic, have studied geography and know a little something about history. When I was a boy I used to know the Catechism from one end to the other, but I'm a little shy on that now."

"Never mind," said McAndrew, "this will be no Sunday school you are going to tackle. How about you, Nelson?"

That descendant of some Norse king gave an outline of his educational career which closely corresponded with O'Rourke's, excepting the Sunday school part. Schmidt and Pierce followed in about the same strain, so that the upshot of it all was that Mr. McAndrew considered his contemplated class was on a par so far as their proposition was concerned.

"I can see right now that I am up against a hard proposition to train you fellows up so as to enable you to take out your papers, but as long as you mean business I am willing to try out your scheme," said the Chief.

"Thank you, sir," was the chorused reply from all four, as light-heartedly they took their departure. Had they been college boys one of them would probably have yelled out, "What's the matter with McAndrew?" to be self-answered in a raucous yell, "He's all right," etc., but they had not yet reached that high degree of culture.

CHAPTER II

School Opens

About two weeks later the *Tuscarora* steamed up the Delaware River to the shipyard where the repairs were to be made, fires were hauled, most of the crew discharged and preparations made to begin the work. The four young firemen and Mr. McAndrew were kept very busy for a time after the arrival of the ship, but it was finally decided that the school should begin on what happened to be the first Monday night of the month. The youngsters in the meantime had rigged up a pretty fair school room in the engineer's storeroom, and had hung up a good-sized blackboard on one of the bulkheads. No testimony was given as to just where they obtained this blackboard, but it is safe to say that the shipyard people must have contributed involuntarily from their pattern and paint shops toward the cause of education.

Monday night, shortly after supper, the first session of the McAndrew School commenced without any frills or formalities. There was no necessity for a roll-call, as a full attendance was in evidence. O'Rourke, Pierce, Nelson and Schmidt had each indulged in a clean shave for the momentous occasion, and McAndrew himself appeared a little more perked up than usual in honor of his debut as a teacher.

Assuming a demeanor somewhat in keeping with his new responsibilities, McAndrew addressed his class as follows: "Young men, we are about to start in our course of training. I don't propose to turn out a lot of high-brows from this floating school, but what I do intend, if possible, is to drive enough theory, or whatever you call it, into you to enable you with practical experience to pass your examinations for a license as assistant engineer before any board you happen to go against. I have been making inquiries to find out just what branches you ought to be drilled on to pass the examination, and I find that the law actually requires only two subjects, and that is how to make calculations concerning a lever safety-valve and how to figure out the staying of the flat surfaces of a boiler. Of course, no man can be an engineer who understands only those problems, and you will find that before you ever get your 'ticket' you will have to get a good general idea of the whole subject, as these local boards are very thorough. These examinations won't be like the old stories they tell about the examinations held in the early days of the civil service, for example, of how a candidate for a job in the Custom House was asked, 'How many Hessians came over here during the Revolutionary War?' Not knowing definitely, he answered, 'A d——n sight more than went back,' and, as the story goes, he got the job. Another one was the candidate for the position of letter carrier, who, when asked, 'How many miles from the earth to the moon?' replied, 'If I have to deliver letters there I don't want the job.' "

"You will find that the questions which the steamboat inspectors ask you to answer will be only such as you must know to make successful marine engineers."

"I therefore propose to post you in a general way on the principal things a seagoing engineer ought to know. I take it for granted that all of you know enough about arithmetic to make ordinary calculations, so we will not waste any time in going over that subject, as you will get enough practice in it as we go along on the other subjects."

"At the start, I will insist on each of you getting a thorough understanding of a few of the elementary definitions in what is known as mechanics, as no one connected in any way with engineering in any of its branches can make a success of it unless he does understand these underlying facts."

(To be continued.)

British Battle Cruiser Princess Royal

BY F. C. COLEMAN

The British battle-cruiser, *Princess Royal,* constructed and completely equipped for service by Messrs. Vickers, Limited, of the Naval Construction Works, Barrow-in-Furness, has established a new world's record for vessels of her class. She is 660 feet long between perpendiculars, 88 feet 6 inches beam, and, with a draft of 28 feet, has a displacement tonnage of 26,350 tons. Like H. M. S. *Lion,* she is the largest cruiser yet built for the British navy, and is also the broadest, excelling even the *Lusitania* and the *Mauretania.*

The eight 13.5-inch guns in the *Princess Royal,* as in the *Lion,* are much more effectively disposed than in the earlier armored cruisers. Forward, there are in the center line two twin-gun turrets, the one to the rear being at a higher elevation, so that its guns fire over the turret in front. Amidships, on the center line, there is one twin-gun turret and aft there is another. Thus all eight guns fire on either broadside and four fire directly ahead, but by giving a slight angle of helm the ship may alter her course sufficiently to enable all eight guns to be utilized in chasing the enemy.

In the *Conqueror,* which belongs to the *Orion* class, there are ten 12-inch guns, arranged two pairs forward and two pairs aft, the rear pair in each case being at a higher level than those immediately in front. The remaining turret is on the center line amidships. There are in both the *Princess Royal* and the *Conqueror* sixteen 4-inch breechloading guns for repelling torpedo boat attack; these are located on the superstructure deck.

In the matter of armor protection something had necessarily to be forfeited in the case of the *Princess Royal,* in order to ensure the exceptionally high speed required by the tactician. This is, perhaps, the only point, with the exception of the omission of two of the primary guns, which differentiates the two types—the battleship and the armored cruiser. As in all British warships, there are three tiers or strakes of armor plating. While the thickness of the waterline strake in a battleship is 12 inches, the remainder up to the upper deck being 9 inches or 8 inches, the *Lion* has, for the waterline and for the strakes above it, 9 inches of armor. The gun positions are also well protected. Forward and aft the thickness of the broadside armor is reduced by gradual stages to 4 inches. It will thus be seen that the *Princess Royal,* notwithstanding her exceptionally high speed, has armor which is superior in its resistance to perforation by modern guns to that of pre-dreadnoughts, so that these latter ships would make a very poor show unless they came within 9,000 yards range, when the guns of the *Princess Royal* would be enormously more destructive than the 12-inch guns of the pre-dreadnoughts. In fact, with their legend speed of 28 knots, as compared with the 17 and 18 knots of the earlier ships, the *Lion* and the *Princess Royal,* as well as the *Queen Mary,* now being built by Messrs. Palmer, at Jarrow-on-Tyne, could steam round a fleet of pre-dreadnought ships and fire when it suited them, keeping beyond the range which would enable the old battleship guns to penetrate the armor of the modern cruiser.

It is often said, of course, that personnel must necessarily be considered, but it is reasonable to assume that the efficiency would be of as high a standard in the new ships as in the old, especially as in the former there is superior gun-control and sighting mechanism, which will insure greater accuracy in service.

The principal steam trials included a 24-hours' run at two-thirds the total power, and an 8-hours' run at full power. Both tests were, of course, carried out at the service draft and under limiting conditions as to air-pressure in the stokehold. The coal consumption on the 24-hours' trial was 1.16 pound per shaft horsepower per hour for all purposes. The power on the 8-hours' run exceeded that required by the contract, and the speed was also considerably in excess of the designed rate, notwithstanding that no attempt was made on the official trial to test the maximum steaming capacity of the boilers. The usual maneuvering and astern trials were also carried out, and one day was devoted to the test of torpedoes and the gun-mountings, which were also supplied by the Vickers Company. The ordnance trials were carried out in record time, due to the precision with which the gun machinery responded to the requirements of the test.

The *Princess Royal* and the *Lion,* being alike both in respect to the form of hull and the propelling machinery, the British Admiralty ordered at the outset two sets of propellers for the *Lion* and two sets for the *Princess Royal.* The *Lion* carried out duplicate tests with the respective propellers, and the second set was fitted to the *Princess Royal* and she carried out the measured-mile trials, corresponding exactly to those run by the *Lion* with the different sets of propellers. The results of all four sets of trials will enable the Admiralty to determine the most suitable dimensions of screw propellers for this type of ship, and these will be utilized in both vessels.

Upon her full-power trials, off Plymouth, the *Princess Royal* attained the high speed for a vessel of her class of 32 knots. But that was not the best she could do. On her return she was drydocked at Devonport and her propellers were changed. She coaled and went out again for six runs at three-fourths and then at full power on the Polperro measured mile. On the last-mentioned occasion it is authoritatively reported that she reached a speed of no less than 34.7 knots, and made an average of 33 knots, which establishes a world's record for vessels of her class. It may be recalled that the original maximum speed of the *Lion* was 29 knots, but that she subsequently made 31.7 knots. The *Princess Royal* was launched at Barrow in April, 1911, and was designed for an official speed of 28 knots, but with the full anticipation that she would do more.

NEW HAMBURG-AMERICAN LINERS.—The Hamburg-American Line recently received from Messrs, Swan, Hunter & Wigham Richardson, of Wallsend, the handsome new liner *Karl Schurz.* On Oct. 25 the same builders successfully launched an exactly similar ship, the *Emil Boas,* named after the late chief representative of the Hamburg-American Line in New York, who died recently. The construction of the ship has been under the superintendence of the owners' resident inspectors, Mr. Claus Hatje and Mr. J. Drieling. The chief dimensions of the ship are 425 feet long over all, 51 feet beam and 33 feet depth. The deadweight carrying capacity will be about 6,100 tons. The twin-screw engines, and also the boilers, are being built by the Wallsend Slipway & Engineering Company. The ship is designed to carry 70 first class passengers and also cargoes of fruit. Electric lighting will be installed and also apparatus for receiving and transmitting radiograms. Messrs. J. & E. Hall, Ltd., of Dartford, are supplying the refrigerating machinery. Messrs. Robson & Sons, of Newcastle-on-Tyne, have in hand the upholstery and the furniture, all of which will be most handsome and comfortable. The music room, dining saloon and smoke room will be luxurious apartments. Special attention is being given to the free ventilation of all parts of the ship. The staterooms for passengers will be unusually lofty and most comfortably furnished.

Note on the Strength of Watertight Bulkheads

BY A. J. MURRAY

It must be the sincere wish of everyone at all interested in the strength of ships that the recently appointed commission in Great Britain will carry their investigations to a point which will, once for all, eliminate the uncertainty which now exists regarding the strength of watertight bulkheads.

Without venturing to criticise the structural strength, or weakness, of the main bulkheads of the *Titanic,* there is much reason to believe that the great majority of bulkheads, as at present constructed, have not sufficient reserve strength. The frame of mind of the designer should be such that he contemplates as a certainty, rather than as a remote possibility, the bilging and laying open to the sea of the compartments of the vessel. Instead of allowing for 15 or 17 tons maximum fiber stress with permanent set under test, the maximum allowable stress under the worst possible conditions should be much less and with practically no permanent set.

Since the 1890 British Board of Trade Committee made their report, much light has been thrown upon the subject by investigators both in England and in America, and the problem has been brought, not to a conclusion, but to a point where judicious and copious experiments can be made with great effect. Practically all watertight bulkheads of modern vessels consist of steel plates, stiffened by vertical bars bracketed to the upper and lower abutments. Present-day investigators seem unanimous in considering that the whole of the water pressure on a bulkhead should be regarded as taken by the stiffeners alone, the tarpaulin or stretching resistance being but a factor and an undependable factor on the credit side. It is now customary to test the more important bulkheads of a vessel by filling a compartment on one side with water at a specified head, and the only experimental data extant are the deflection, permanent set and general behavior of bulkheads under such tests.

Adopting the usual method of regarding the stiffeners and the narrow strip of bulkhead plating in their vicinity as girders, we come at once to one of the difficulties which experiment alone can overcome.

We require to know:

1. How broad a strip of the bulkhead plating can be taken to act with the stiffener and form a covering plate of same.

2. In treating the girder as a beam what span should be taken?

3. To what extent do the end brackets constrain the stiffener under load.

4. What proportion of the deflection under test is due to elastic bending, apart from the residual deflection due to creep of the riveted attachments and shear.

The most thorough experiments yet made to determine the relation between calculated and actual deflection of girders are those described by Dr. Bruhn in the Transactions of the Institution of Naval Architects for 1905. Dr. Bruhn used a 12-inch covering plate for his girders. Mr. Norton, in his investigations of the strength of watertight bulkheads, assumed a breadth equal to three times the bulkhead flange of the stiffener, and more recently Capt. Hovgaard a breadth about one and a half times that of the bulkhead flange.

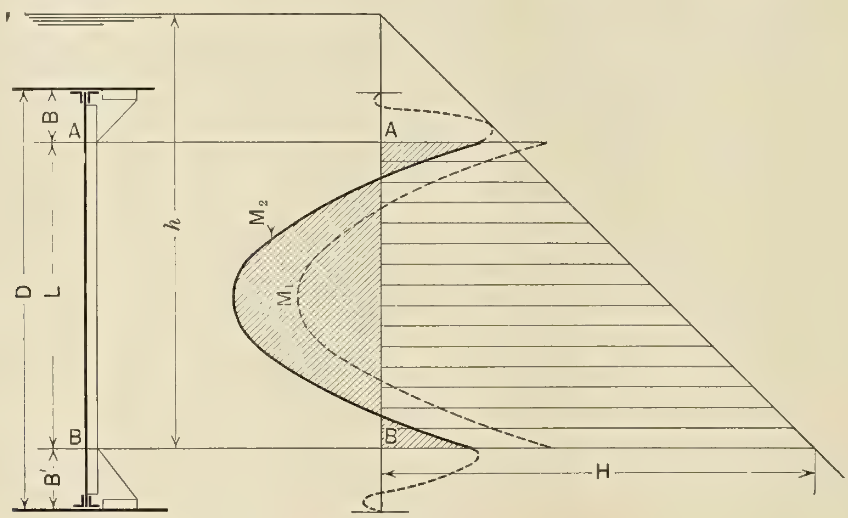


FIG. 1 FIG. 2

To see what difference the breadth of the covering plate makes in the resultant stiffness, take the case of a 10-inch by 3⅜-inch by 3⅜-inch by 21.7-pound channel stiffener riveted to a 12-pound bulkhead: With no cover plate the modulus is 18.3, with a 3⅜-inch cover plate the modulus is 22.2, with a 6-inch cover plate the modulus is 25.7, with a 12-inch cover plate the modulus is 33.5, and with a 30-inch cover plate the modulus is 55.5, so that with a 12-inch cover plate the fiber stress for the same bending moment is 50 percent less than with a 3⅜-inch cover plate.

Only by careful experiment can this crucial question be answered. The method of experiment should be to bend a set of individual stiffeners under known conditions (say free ended) and then to bend the same or a similar set when riveted up to plates. By comparison of the deflections we should determine how much of the plating should be regarded as working with and supporting the stiffeners.

Again, the exact usefulness of the brackets at top and bottom of the stiffeners can only be determined by experiments carried out for different classes of bulkheads and the careful analysis of the tests already made. The reactions and stresses to which stiffener brackets are subject have been treated with great skill, but however useful these investigations with regard to the design of the brackets themselves, they do not furnish

a reliable starting point when considering the whole bulkhead. The question of the strength of the bracket attachments involves the further question of what length of the stiffener should be considered as the girder span when applying the ordinary beam formulæ to obtain the elastic deflection. Some investigators take the span as the full length of the bulkhead stiffener, some as the inside distance between the brackets, while others, again, take some intermediate length.

Briefly the investigator appears to proceed thus:

1. Decides whether he will assume the stiffener girder as free or *encastre*.

2. Having adopted one of these points of view, chooses a girder span and breadth of bulkhead strip, which will make his calculated deflection agree with that observed under test.

3. Makes some calculation as to the behavior of the brackets, so as to justify the span chosen.

When such an investigation is confined to a particular class of bulkhead, an empirical law can be obtained giving fairly good results. But such a method lacks generality.

The method we strongly recommend is similar to that used when analyzing a series of bulkhead tests, the result of which investigation were published in 1909.*

Consider the ordinary case of a bulkhead having vertical stiffeners bracketed at top and bottom. Fig. 1 shows in section a stiffener element of such a bulkhead:

$D =$ depth of bulkhead.

$L =$ inside distance between brackets.

$h =$ head of test water above the bottom of bulkhead.

Between the inside terminals of the brackets—*i. e.*, between A and B in Fig. 1—we have a girder subject to a given pressure load, indicated by the hatched area in Fig. 2. If, now, we know what the bending moments at A and B are, then all the stresses for the girder AB are known, and this quite independently of what the bending moments are above and below the points A and B, which latter bending moments depend on the type of bracket used.

Suppose M_1 (Fig. 2) is the curve of bending moments from A to B on the supposition that the brackets absolutely fix the girder at A and B. Then the actual bending moments are represented by some such curve as M_2. The actual bending moments at A and B are thus less than those given by curve M, and this ratio we term the degree of constraint. Knowing, then, this degree of constraint, we are able to determine definitely all the stresses on the stiffener girder AB.

Experiment alone can determine the degree of constraint. For the series of tests analyzed, it was found that the bending moments at the girder ends were about half that calculated on the assumption of absolute fixidity—i. e., about 50 percent constraint. The method used was that of comparing the calculated and observed deflections, but when publishing the results, no exact expression was given for calculating the deflection.

Referring to Fig. 1, the head of water above the bottom of the girder AB is $D - B^1 = H$, and putting

$$\frac{\text{head}}{\text{span}} = \frac{H}{L} = \alpha,$$

the perfectly general formula on the assumption of fixed ends for the bending moment at A is $\frac{L^2}{12}(\alpha - 0.6)\,W$,

and at B is $\frac{L^2}{12}(\alpha - 0.4)\,W$,

where $W = b + 0.279$.

$b =$ breadth of plating strip in inches.

$L =$ span in feet.

Test water taken at 62.5 pounds per cubic foot.

As, however, the constraint is not absolute at A and B, the end bending moments are only a fraction of these.

Suppose β is this fraction (or degree of constraint), then the bending equation for the girder AB, reckoning from the lower end, is

$$M_x = EI\frac{d^2y}{dx^2} = R_b\,x - \frac{W\alpha L x^2}{2} + \frac{x^3}{6}W + \beta M_b - \frac{x}{2L}\beta(M_b - M_a)$$

where R_b is the reaction at B on the supposition of free ends.

Integrating out we obtain

$$\Delta = (30\alpha - 15 - 24\alpha\beta + 12\beta)\frac{WL^5}{64EI} \qquad (1)$$

where Δ is the deflection at the middle of the girder AB.

For fixed ends $\beta = 1$,

$$\text{giving } \Delta = \frac{3L^5}{8EI}(\alpha - \tfrac{1}{2})\,W.$$

For free ends $\beta = 0$,

$$\text{giving } \Delta = \frac{15L^5}{8EI}(\alpha - \tfrac{1}{2})\,W.$$

Comparing the observed deflections under test with the theoretical deflection given by equation (1) we obtain the value of the constraint β, and thus know the stresses at every point of the girder. Before making this comparison, it will, however, be necessary to bear in mind that the observed deflection is, in fact,

bending deflection + residual deflection.

A glance at the results of Dr. Bruhn indicates that for such a stiffener as that quoted above, with a 12-inch cover plate, we should have

Residual deflection equals: Span of 10 depths, 60 percent bending deflection; span of 14 depths, 50 percent bending deflection; span of 50 depths, no bending deflection.

The observed deflection will thus require to be modified according to the depth and type of stiffener.

The residual deflection as taken here contains the shear deflection, which could be calculated separately and will be found to be a considerable proportion of the whole for short stiffeners having thin webs.

For the form of stiffener quoted the approximate relation is expressed thus:

$$\frac{\text{Shear deflection}}{\text{Bending deflection}} = \frac{15\,Af}{Aw}\left(\frac{h}{L}\right)^2$$

where $Af =$ area of flanges.

$Aw =$ area of web.

$h =$ depth of girder.

$L =$ span of girder.

It will probably be found more practical to determine the total residual deflection per unit length of stiffener for different forms of section.

In conclusion, this general method lends itself to standardization.

Thus, instead of using Δ we can use

$$\frac{\Delta\,64\,EI}{WL^5} = d.$$

Then, no matter what the dimensions of the bulkhead, "d" would be the same degree of constraint "β" and same head ratio "α."

* Proceedings of the Northeast Coast Institution of Engineers and Shipbuilders.

The Twentieth Annual Meeting of the Society of Naval Architects and Marine Engineers

The twentieth annual meeting of the Society of Naval Architects and Marine Engineers was held at the Engineering Societies' building, New York, Nov. 21 and 22. Morning and afternoon sessions were held each day, and the meeting closed with a banquet at the Waldorf-Astoria on the evening of the 22d. The meeting was opened with an address by Stevenson Taylor, president of the society. Following this the report of the secretary and treasurer was read, showing a membership of 785, as compared with 733 last year. The financial statement showed a balance of $18,000 (£3,700), as against $8,000 (£1,640) last year. Col. Robert M. Thompson, of New York, was unanimously elected president for three years, beginning Jan. 1, 1913, and D. H. Cox was re-elected secretary and treasurer. It was voted that the society participate in the Panama-Pacific Exposition in San Francisco in 1915, and that the sum of $2,000 (£410) be raised for this purpose. Fourteen papers were read and discussed during the meeting, abstracts of which follow:

No. 1—Experiments on the Fulton and the Froude

BY PROFESSOR C. H. PEABODY

(This paper will be published in the January number.)

No. 2—The Design and New Construction Division of the Bureau of Construction and Repair of the Navy Department

BY NAVAL CONSTRUCTOR R. H. ROBINSON, U. S. N.

Abstract

This article deals only with the methods of handling an organization engaged in design and in passing on matters of new construction, leaving the work produced to speak for itself. The Division of the Bureau of Construction and Repair produces in general:

(*a*) Estimates for new construction.

(*b*) Preliminary designs for ships, including plans and calculations.

(*c*) Contract designs for ships, including plans, calculations and specifications.

(*d*) Action on contractors' plans and on specifications for auxiliaries submitted by builders.

(*e*) Standard plans and miscellaneous design work.

Incidental to each of these are many duties, some of which are handling the reports of boards on changes on ships, the compilation and tabulation of data for use in one of the main duties mentioned above, preparation of allowance lists, design and record of issue of small boats, preparation of annual report and ships' data books, etc. A definite section also handles the question of reports of the trial board, takes action on the more important alterations to ships in service, etc.

The endeavor is to produce the greatest amount of work possible with a minimum effort and in a minimum of time.

With the object of saving time, a complete study has been made, and a number of what the writers consider the most important features of modern shop methods have been adopted, particularly in routing, assigning and planning work, making provision for consultation with responsible officers without delay, etc.

The division is divided into five parts:

1. The "office."
2. The electric branch.
3. The criticism branch.
4. The design and scientific branch.
5. The blue-print room.

No. 4 is further divided into two parts—the design room and the scientific and computing room—but both work directly together and directly adjoin. The design room also includes the specification desk.

The Office.—In the office is desk space for four officers, the writer and three assistants. Frequently one of the officers must be absent on other duties, but one of the officers, the senior assistant present, is always at the desk to handle papers, answer the telephone and keep in touch with all ends. Another assistant spends practically his entire day in the criticism branch, going from desk to desk, giving instructions, answering questions, etc. The third assistant is at present developing a special line of work, which also keeps him in the criticism branch. Eventually it is hoped that it will work out that there will be an officer continually in each of the design and criticism branches. The head of the division spends about one-quarter of his time at his desk, and the balance with the chief constructor, in the drawing offices, mostly in the design and scientific branch, or in expediting inter-bureau work about the department. It is the writer's duty as the head of the division to keep the chief constructor informed of the work of the division and to keep advised of his wishes as to the details of the work.

The Electric Branch.—The electric branch, which immediately adjoins the office, is directly controlled by the officer at the desk. It includes the Bureau's electrical aide and the assistant electrical aide. Its work consists of preparation of and action on electrical specifications and plans, passing on electrical test reports, design of electrical auxiliaries, keeping track of electrical subordinates outside the Bureau, and, in general, all electrical questions before the Bureau. Special investigations of new electrical applications for the Bureau's work on board ship are made in or directed from this branch.

The Criticism Branch.—This branch examines and criticises: (*a*) Plans produced in design branch before issue; (*b*) plans and specifications submitted by builders in developing the details. It employs a chief draftsman, his assistants and fifteen draftsmen with stenographers and plan clerks. This branch is organized on the functional system, each employee or group of employees handling a specialty or kindred specialties. The specialties covered are considerable in number, and are divided generally as follows, with one or more employees to each sub-division:

Changes; allowance lists and small boats; plans, their filing, correction and distribution to navy yards; joiner work and general arrangement; repairs and alterations of ships in the fleet, trial reports, etc.; structural work; auxiliary machinery and mechanical details; ventilation, drainage and piping systems; turrets, gun emplacements and armor; submarine boats; miscellaneous.

In this room are kept only the plans of ships building and one or two classes back (those most constantly referred to). The balance—a very large number—are kept in fireproof vaults at the Washington navy yard.

The Scientific and Design Branch.—This branch produces the plans, specifications and calculations for new ships of the navy. It is under the direction of a leading draftsman with another leading draftsman directly in charge of the design plan room itself. The design plan room contains ten draftsmen, eight of whom make and trace the plans and two prepare the specifications, filling what is called the specifications desk.

Scientific and Computing Room.—The scientific and computing room contains thirteen draftsmen at the boards engaged on all kinds of scientific investigations, calculations and computations as to ships.

The Blue-Print Room.—This is in two parts—one in the Bureau and the other at the navy yard, increased facilities being needed to take care of all the blue-prints required by the Bureau.

Method of Work.—The products of the division enumerated above nearly always result from the receipt of a letter. The paper explains in detail the method of routing and assigning such letters to the different departments, giving instructions, supplying materials, obtaining the proper action and recording progress, together with mention of the numerous schemes devised to increase the efficiency of the work.

The system outlined above is a development of many years of experience in this character of work, and the writer claims no special credit for it. The fundamentals of the organization were determined under a former president of this society when he ably held the position of chief constructor of the navy. The development has gone on under the writer's immediate direction during the incumbency of Chief Constructor Capps and his successor, the present Chief of Bureau, Chief Constructor Watt. The credit, if any, is due as much to the individual employees as to any one, as through their suggestions many, if not most, of the improvements have been made.

No. 3—Engineering Progress in the U. S. Navy

BY CAPTAIN G. W. DYSON, U. S. N.

(This paper is published on page 490.)

No. 4—Marine Lighting Equipment of the Panama Canal

BY JAMES PATTISON

ABSTRACT

In accordance with the plans of the eminent army engineers who are carrying the work to completion, the Panama Canal will be lighted throughout by automatic unattended lights, each having a distinctive characteristic. At the entrances and through Gatun Lake a double row of about sixty automatic acetylene-lighted buoys will mark the channel. The channel will be further defined by powerful, rapid-flashing range lights, one set at either end of each successive tangent, thus permitting vessels going in either direction to take their range over the bow. The center lines of each range are set apart sufficiently to enable the largest vessels to pass one another in safety. Through the Culebra cut, or wherever the proximity of the banks permits, beacons will be used instead of buoys.

The Panama buoys consist of a cylindrical body or chamber, 8 feet in diameter, made of 5/16-inch steel plate with dished heads riveted on. Through the center of the body passes a tube, to which is bolted a counterweight. A pyramidal skeleton tower is bolted to cast steel foot brackets, and carries the lantern at a focal height of 15 feet. The draft of the buoy is 12 feet, and the total weight without anchor chain 10,500 pounds. Before painting and shipping the buoy is subjected to a hydrostatic test of 15 pounds per square inch. With reference to the gas supply and lighting apparatus, there are four accumulators, filled with dissolved acetylene and inserted in pockets, furnished with hinged covers for facilitating the removal and renewal of the accumulators. The lantern contains the pressure regulator or governor and the flashing mechanism. The high-pressure gas is led from the accumulators to a manifold, thence up a leg of the tower and through a shut-off valve to the governor.

The system of storing acetylene in portable accumulators is known as Dissolved Acetylene (D. A.), and is based upon the properties of acetone in combination with a suitable porous substance. The type of accumulator used on the Panama buoys is tested to 75 atmospheres, and completely filled with the porous mass, a solid material possessing a porosity of 80 percent. That is to say, although the cylinder is apparently filled quite full, only 20 percent of the pace is really occupied by the solid body, the remaining 80 percent being available for holding the liquid. Half of this remaining space is occupied by acetone, which soaks into every pore of the porous substance; the other half, or 40 percent of the original volume of the cylinder, is thus available for the expansion of the liquid. The cylinder is closed by a reliable valve, through which the gas is pumped into the accumulator, and through which it flows out again when required for service.

As the acetone charge is equal to 40 percent of the original volume of the cylinder, and the solvent capacity of acetone is twenty-five times its own volume per atmosphere of pressure, the acetylene storing capacity of the accumulator is, accordingly, ten times its own volume for each atmosphere. Therefore, at a pressure of 10 atmospheres an accumulator contains 100 times its own volume of acetylene; at 12 atmospheres 120 times, and so on, this being computed for a temperature of 15 degrees C. (59 degrees F.).

A notable feature of dissolved acetylene is that its usefulness is independent of the temperature. It should, however, be observed that changes of temperature, although in no way interfering with the usefulness of the gas accumulator, cause corresponding changes of pressure inside the accumulator. These variations of the pressure will only slightly affect the gas quantity at disposal; however, every atmosphere's pressure indicated by the pressure gage does not, at all degrees of temperature, represent the same quantity of gas at disposal. As the porous substance is not a very good conductor of heat, only a prolonged change in the temperature will materially affect the temperature in the interior of the accumulator. Replenishing of the acetone at intervals, together with occasional painting, is the only item of up-keep connected with the gas accumulators.

From the foregoing it will be seen that acetylene is stored in the accumulators under varying degrees of moderately high pressure. At the burner, however, a constant low-pressure is required; therefore the gas must be passed through a pressure regulator or governor to reduce the high-pressure to the required low constant pressure. By this means, irrespective of the gas pressure in the accumulator, whether high or low, and of the gas consumption, whether large or small, the gas always issues from the governor at the constant low-pressure suitable for the burner

An entirely new principle in flashers permits the production of as many as 55,000 separate and distinct flashes from 1 cubic foot of acetylene. The new flasher may be adjusted to give light periods of any desired length of time down to one-tenth of a second, or less, alternating with dark intervals of any desired length. Single, double or triple flashes, etc., can be produced with ease; in fact, any light character obtainable in lighthouses equipped with the most modern lens arrangements can be produced by the new flasher. For lighting the gas as it flows out of the burner during the light periods, a special pilot burner is used.

It is naturally of the utmost importance for the safety of navigation that the light character, *i. e.*, the ratio between light and eclipse, after having once been fixed must not vary in the slightest degree. Of the light characters adopted by the army engineers for the lights on the Panama Canal, the flashes do not in any instance exceed two seconds' duration, and the majority will be set to .3 of a second.

The Panama Canal buoys will all be equipped with sixth order lanterns. With a 1-foot burner of 46 Hefner candlepower (the size adopted for the Panama buoys), the efficiency of the light through the lens will be 400 Hefner candlepower, visible at a range of about 11½ nautical miles. Such great candlepowers are obtainable on account of the high intrinsic

brightness of the acetylene flame, which, being relatively small in size, permits of almost exact centering at the focus of the lens. Lenses consisting of ground glass elements are now used in all modern lighthouse apparatus, the system employed for buoys being known as the Dioptric System, in which the light from the luminous source is collected and caused to travel along a horizontal plane by refraction. The sixth order (300 mm.) Fresnel lenses for the Panama buoys are composed of nine separate elements, cemented together and held securely by a brass frame of helical bars. To secure the maximum efficiency from the lens, the vertical bars of all standard buoy and beacon lanterns are equipped on their inner side with totally reflecting glass prisms, arranged so that the light which falls on any one prism is reflected out into the shadow caused by the adjacent bar. By a patented device all of the light which emanates from the lens is effectively turned to account and uniformly spread throughout the complete horizontal plane, whereas in all other types of lanterns much of this light is obstructed by the bars and lost.

Although not employed on buoys, a brief description of the sun-valve, the invention of the Swedish engineer, Gustaf Dalén, is given in closing the paper. The sun-valve controls the flow of gas to the burner so that the light will burn and gas be consumed only when actually required; that is, during darkness, thus effecting great fuel economy and increasing the service capacity of the accumulators. It is actuated entirely by light, and operates quite independently of temperature, so that it may be employed in any climate of the world. Its construction and operation are based on the well-known physical law, that a body with a light absorbing surface attains a higher temperature, and consequently expands more than a similar body with a light reflecting surface when both are exposed to the same light.

No. 5—Notes on Life-saving Appliances

BY W. D. FORBES

Abstract

The greatest stress of both the American and English committees on safety at sea since the *Titanic* disaster seems to have been laid on the matter of lifeboats, that enough of these should be provided for all on board, and in the United States, at least, the construction of lifeboats has been much improved. The most noticeable advance is in making the air tanks in metal boats independent of the shell plating; in other words, demanding a self-contained and detachable buoyancy medium. In the matter of seams for the air tanks the question of brazing or riveting and soldering has been settled, allowing a folded seam, soldered, of course, in the place of a riveted or welded one. The original demand for gunwales of 26-foot boats and under was that they should be in one piece; this has been modified and a splice is now allowed. The use of a steel keel, while more expensive, is a very great gain over the use of a wooden one. It makes a stiff boat and adds strength to resist the strain when lowering or hoisting a loaded boat. There does not seem to be any great debate as to the relative values of wooden or steel boats; both are allowed, yet the metal construction appears to be rather the favorite, as it is lasting and always tight, while the wooden boat is never so.

It is clear from the investigations that life-boats are the most important lifesaving appliances; but these, of course, would be useless without efficient means of launching them, and therefore a good davit is a matter of first importance. The requirements of a good davit are named as strength, simplicity of action and perfect control. To what extent the various davits now on the market meet these requirements is explained in detail in the paper. Then the question of releasing devices and hoists is discussed. After describing the new double-decked lifeboat invented by Capt. A. P. Lundin, the author states that his ideal of lifeboat equipment includes a seaworthy boat of solid construction, davits which are worked from the ship's deck independently and with variable reach, a fall which is entirely controlled by a man in the boat, and a releasing device which can be made automatic or self-releasing when the boat is water-borne, or that can be detached at either end or both simultaneously. For returning the boat to the deck he believes a power system should be fitted to at least two boats on each side, so that for rescue work the boat can be brought up with a run to avoid being swamped in lifting. In rescue work, moreover, there is no reason why power cannot be applied as it would be available. The other boats carried would only be used if the ship was abandoned, and a quick power-return on these is not so desirable, because no master would hold boat drills in weather which would endanger lives and the boat; but for rescue work it seems that a quick power hoist is imperative, and it must be under control of a man in the boat. There are three conditions which must be considered in handling lifeboats: 1. Drill, when power is available. 2. Abandoning ship, when power would probably not be available nor would it be required. 3. Rescue work when power is available.

On Oct. 22 and 23, the United States transport *Kilpatrick* was used by the Board of Lifesaving Appliances to test out the various designs of davits, releasing devices, lifeboats and rafts, etc. The tests began with swinging out the Lundin lifeboats which were nested on the upper deck, 33 feet from the water, Welin davits being used; these are of the quadrant type. The boats proved most seaworthy and thoroughly satisfactory in every way. A most interesting experiment was tried by suspending one of the boats about 6 feet above the water and passing a line to the tug *Reno*, which hauled the boat out about 6 feet and allowed it to swing back against the ship's side. In no way were the lifesaving qualities of the boat impaired by this test. The circumstance of the test was that the *Kilpatrick* was listed 5 degrees, which at the moment of test was added to by at least 3 degrees, making a total of 8 degrees, by a squall which had come up coupled with a driving rain and a wind of about 30 miles an hour; the ship was not rolling and the Lundin boat was on the weather side; the weight of the boat was 2,259 pounds.

Later two Lundin boats were made into a pontoon. The pontoon was of the simplest construction, requiring no nailing, and only four bolts to hold it in place. This provided a platform of 575 square feet, floating 2 feet 3 inches from the surface of the water. When loaded with 91 persons, the value of such a platform for discharging stores or taking them in, landing troops with their horses, as a staging to bring boats up to, will be apparent to all military men. This pontoon was towed by a launch with great ease and maneuvered readily by four men sculling.

A lifeboat of the Ingersoll type was thrown from the deck of the *Kilpatrick* into the water. She struck bow on, almost disappeared, righted herself and was self-bailed, clear of water in 14 seconds.

A very interesting, practical and convincing test, which showed the disadvantage of the pin-type davit, was as follows: The *Kilpatrick* was listed 6 degrees, a pin-type davit fitted with a special handling device was tried, and the following time was noted:

Weight of boat, 2,250 pounds; 6 men in the boat; 7 men at the cranks. Under these conditions the boat could not be swung out. The men were taken out, and the 7 men heaving at the cranks were hardly able to get the boat outboard in 5 minutes 10 seconds. Later, with 7 men in the boat and an extra effort of the 7 men, the boat was got out in 8 minutes 2 seconds, but the men at the crank had to be "spelled."

Under the same condition of list the quadrant type of davit showed:

Weight of boat, 3,250 pounds; 11 men in the boat; one man at each crank; 1 minute and 40 seconds.

With a round-bar davit and the ship on an even keel the time given below was required:

Weight of boat, 2,250 pounds; 18 men in the boat; 10 men at the davits; 5 minutes 15 seconds were required to swing it outboard; only damage done was a little denting of the bow when she went over the side. This boat was fitted with square holes for bailers, which passed directly through the deck, and also the plating, with no obstruction whatsoever. It came on to blow, and this boat could not be made fast to the falls, so she was towed astern, and with these open scuppers the effect was very much that of a system of miniature geysers. Later boats of this construction are provided with means to prevent this.

A number of releasing gears were tried out, all with more or less success; in fact, it might be said that all of them performed the operations expected of them, but only one of them seemed to meet the demands of absolute simplicity.

No. 6—Developments in Oil Burning

BY E. H. PEABODY

(This paper will be published in the January number.)

No. 7—The Preservation of Metals Used in Marine Construction

BY LIEUT. COMMANDER FRANK LYON, U. S. N.

(This paper will be published in the January number.)

No. 8—An Electrically Propelled Fireproof Passenger Steamer

BY W. T. DONNELLY AND G. A. ORROK

(This paper is published on page 498.)

No. 9—Notes on Fuel Economy as Influenced by Ship Design

BY E. H. RIGG

(This paper is published on page 496.)

No. 10—Active Type of Stabilizing Gyro

BY ELMER A. SPERRY

Abstract

The stabilization of ships has been undertaken by two methods: First, by changing the center of gravity of the mass as a whole, as by the damping tanks of Sir Philip Watts and later workers, and the moving weights already successfully applied by Sir John; and, second, by employing the already very great longitudinal stability or rigidity by deflecting same in to the athwartship plane. The ship by this means may be rendered stable almost without limit and up to the breaking-down point of the gyroscopic couple, which has now come to be recognized as of simple origin and of very great magnitude, especially as compared with the weights involved.

Some of the early attempts to use the gyroscope were unfortunate in that the gyro was passive, therefore free and uncontrolled as to its precessional movements. Experience has now been had in actual sea trials which confirm statements often put forward by the author heretofore, urging the great importance of having these precessional movements of the gyro at all times under perfect control. This control on the one hand sets a constant limit to the otherwise almost limitless power of the gyro couple, while on the other hand it allows us to apply a measured stress of any desired magnitude, duration or direction and timed with precision. In this manner the very great longitudinal metacentric height is available for athwartship purposes, and may be in any desired amount added to the athwartship component. In fact, the point has now been reached in this development, as demonstrated by sea trials, that the amount of the great longitudinal stability utilized athwartship may be always quantitative and proportional to the needs. With the adjunct the ship itself may be very tender and of low metacentric height, because, as above stated, any desired amount of the very great longitudinal metacentric height may be added at will athwartship, and this without any regard to the rolling period of the ship. In this manner a comparatively small apparatus can be utilized in effectually holding the ship against motion, simply because each increment on the instant, and simultaneously with its development, is completely subjugated and neutralized before it has time to move the ship.

The gyro constitutes an ideal apparatus for this work, inasmuch as it is perfectly safe. It is unnecessary to run the wheel at any but comparatively low stresses. In fact, the stresses present can be brought below those used in hull practice. The comparatively slow motion of the wheel is very inexpensive to develop and maintain, representing only a small fraction of the power required to propel bilge keels; and this power, small as it is, is only required when the necessity for stabilizing arises, and then only in proportion to the seas running at the time, whereas the power for the bilge keels is omnipresent; that is, it is a constant drag in all weathers. The power for operating the precession is trifling, only sufficient to absolutely control and limit the precession movements at all times. This arises from the fact that the constant tendency of the ship is to do precession-wise work upon the gyro. The power required for the precession engine is almost nil, it being only sufficient to control the implacement of the positive and negative energizations delivered to the ship.

The paper discusses the advantages of the active type of gyroscope as compared with other methods of stabilizing ships. The gyro equipment of the U. S. S. *Worden* is described in detail. In closing the author states that our knowledge of the amount of work derived from the active stabilizing gyros herein described, while acting under these new conditions, is now such as to enable us to calculate with all necessary accuracy the weight and space occupied in connection with any plant; also to predict with accuracy what the results will be, the amount of power required, and also to prescribe, with a fair degree of certainty, about what stabilizing factor under the new *modus operandi* would be satisfactory with any given ship.

No. 11—Rudder Trials, U. S. S. Sterett

BY ASSISTANT NAVAL CONSTRUCTORS R. T. HANSON AND J. C. HUNSAKER, U. S. N.

Abstract

The objects of these trials were: (1) To determine the moment of pressure on the rudder in turning at varous speeds and helm angles; (2) to compare these values with the corresponding values given by Joessel's formula, and to obtain a coefficient of reduction thereon; (3) to establish a formula directly applicable to this particular type of vessel, and (4) to investigate the condition of "meeting ship" with the helm when already turning, and the condition of turning with engines reversed.

It is believed that previous published turning trials have been conducted at speeds not greater than 20 knots, and that particular interest attaches to these trials on account of the high speeds (28 knots maximum) at which they were run.

The trials for the conditions of "meeting ship" and "backing" were made for the purpose of obtaining data which, it was hoped, would be of interest in the design of steering gear for ships of a type similar to that tested.

For these turning trials, the U. S. S. *Sterett*, a destroyer of recent design, was designated by the Navy Department. The trials consisted in securing, with a recording spring dynamo-

meter, a continuous record of tension in the standing part of one tiller chain, together with records of time, helm angle and revolutions of both turbines.

The results of the tests have been summarized in curves of twisting moment, both maximum and on steady turning, coefficients of reduction on Joessel's values and an approximate empirical equation.

Turning trials underway were carried out in Massachusetts Bay in the vicinity of Boston Light Ship. The sea was smooth with a long ground swell. The mean displacement of the ship was 835 tons, 12.7 percent greater than the displacement on standardization. The depth of water in which the trials were run varied from 12 to 20 fathoms.

The procedure for a run was as follows: The ship was put upon a steady course at the desired speed (the corresponding revolutions per minute being maintained as nearly as possible except during actual turning, when the throttles were not touched). After steadying on course and speed for a reasonable length of time, a "stand-by" was given to the engine room and to the man in charge of the dynamometer and gear aft. The order was given to the helmsman "starboard 25 degrees," etc., and simultaneously a "start-turn" signal was given by bell to the engine room, and a "jog" transmitted to the record roll. As the ship's head swung past 10 degrees, 20 degrees and 30 degrees by steering compass, one, two and three notches were transmitted to the "signal" line on the record roll. Since a practically steady value of stress was in every case reached at 40 degrees to 60 degrees of swing, the turn was considered finished after swinging through eight points. The helm was then put amidships and the ship steadied on her course at the speed desired for the next turn. On each turn the time to put helm over was checked on a stopwatch, and the helmsman was coached to secure a uniform rate. The average rate at which the helm was put over was 3 degrees per second.

For convenience the tests were begun at the lowest speed. The "meet ship" turns were run in wherever the speed of ship, and capacity of dynamometer spring already fitted, made it convenient. The full-power backing trials were made immediately after the turns at maximum speed ahead, and the trials were concluded with the backing turns at reduced power.

Three turns were made at each helm angle; four different helm angles were used at each speed, and there were five speeds ahead, in addition to "meet ship" turns and full power and reduced power backing turns. The total number of turns made was 74, and the total time required was seven hours.

The "meet ship" turns consisted in steadying on a course at prescribed speed, then putting the helm first port a certain number of degrees, then starboard. Continuous records were made and maximum and "steady" stress obtained for various conditions, such as "meeting" the ship with starboard helm immediately after the helm had been put aport, and "meeting" her at various intervals of time after the ship's head had begun to swing to starboard.

Backing turns were made both at full power and at reduced power. The backing turns at full power are of particular interest, because they give twisting moments more than 1.5 times as great as the maximum moments obtained on the turns at the highest speeds ahead.

The instant the helm starts to move, in beginning a turn, the force recorded on the dynamometer begins to rise, and reaches a maximum at about the instant the helm reaches its maximum angle. During this time the ship first gives a slight kick to starboard (assuming helm put to starboard), then starts to turn to port. As she continues to turn, the tension in the tiller chain falls off somewhat and then maintains a practically uniform or "steady" value after a swing of 40 degrees to 50 degrees. The ship then turns uniformly in her normal turning circle, and as there is practically no further variation in the ordinate of the force curve the turn is considered finished after a swing of 90 degrees. As soon as the helm is put back amidships the tension in the tiller chain falls rapidly to its initial value.

The data obtained in these trials are presented in tables and curves, and a formula is proposed for twisting moments in terms of the rudder constants. The conclusions set forth from these trials are as follows:

1. A given coefficient of reduction for Joessel's formula may be applied to similar ships, with rudders of the same type, only for the same helm angle and at corresponding speeds, *i. e.*, $\dfrac{V}{\sqrt{L}}$ = constant.

2. In turning with the helm alone, the maximum tension in the rudder chain (including friction of gear) occurs at the instant the helm has reached its extreme position, and amounts to 139 percent of the tension when the ship is turning uniformly at 28 knots and 35 degrees helm.

3. The maximum twisting moment on the rudder post occurs at the same instant as (2) above, and amounts to 130 percent of the moment when ship is turning uniformly at 28 knots and 35 degrees helm.

4. The rudder moment to "meet ship" when turning amounts to about 112 percent of the moment, exerted in steady turning with same speed and helm.

5. The effect of waves of height about 4 feet is to produce a maximum moment when turning of 135 percent of the maximum moment when turning in quiet water.

6. The force exerted by the steering engine to overcome the friction of the leads to the rudder yoke is 24 percent of the maximum force exerted on turning at 28 knots and 35 degrees helm in quiet water. This seems to be a disadvantage of a location of the steering engine forward in a ship of such length.

7. The greatest moment measured during these trials was obtained in backing full power with full helm. The rudder moment for this condition amounted to 1.6 times the moment recorded on steady turning at 28 knots and 35 degrees helm.

With the results of these rudder trials at hand it would be of interest to determine, with precision, the path of the *Sterett* in turning with a view to establishing the relation between the rudder moment and the maneuvering qualities of this type of ship.

To afford data for the design of steering gear and rudder posts, using a definite factor of safety, such rudder trials as are described in this paper should be conducted in rough weather.

No. 12—Logarithmic Speed-Power Diagram

BY THOMAS M. GUNN

Abstract

To logarithmic diagrams of one type or another the modern engineer is indebted for the rapid and easy solution of many cumbersome formulæ. The calculations which yield themselves most readily to its use are those involving products, quotients or powers of numbers. It matters little what the exponent is, the solution of a formula consisting of (a constant) × (a variable) raised to any known power, requires for its repeated solution only the drawing of one straight line, and thereafter for any value of the variable within the range of the diagram the result is read off directly. For such purposes it is common to use logarithmic co-ordinate paper, which is available in two or three sizes. Diagrams have already been used repeatedly for the calculation of frictional resistance of ships. It is not desired in this paper to present new information upon the power of ships or propellers, but rather to sub-

mit a means of convenient application of the laws of comparison for ships and propellers.

The following table summarizes some of the commonly known relations between similar ships of different size. For convenience, all of these relations are stated in the last column in terms of speed:

FUNCTION.	Quantity in Proportion to which Function Varies, in Terms of: L.	D.	V.
Length or other linear dimension, L	L	$D^{1/3}$	V^2
Surface, S	L^2	$D^{2/3}$	V^4
Speed, V	$L^{1/2}$	$D^{1/6}$	V
Displacement, D	L^3	D	V^6
Wave resistance (residual)	L^3	D	V^6
Wave power	$L^{7/2}$	$D^{7/6}$	V^7

The fact that both the exponent and coefficient of friction vary in the formula for frictional resistance makes it impossible to introduce this term directly in the laws of comparison. Detail calculation shows that if frictional horsepower be calculated for two similar surfaces at corresponding speeds, the ratio of horsepower is very closely approximated by the 6.735 power of the speed ratio, or the 3.3675 power of the length ratio.

This relation holds most closely for surfaces above 50 feet in length, but is a good approximation even as low as 10 or 15 feet in length.

Since friction power of the ship varies nearly as the 6.735 power and residual power as the seventh power of the speed for similar hulls at corresponding speeds, it may be expected that their sum or effective horsepower will vary as some power of the speed between 6.735 and 7. It is somewhat variable, dependent upon the ratio between frictional and total resistance or power.

In common practice the power consumed in surface friction is from 50 to 60 percent of the effective power, as low as 40 percent only in very high-speed craft, and dropping possibly to 10 percent in hydroplanes or rising to 90 percent at low speeds for long cargo vessels. It may be stated that for normal designs, from full boats of low speed to fine forms of high speed, there is not much error in assuming the exponent of reduction to be about 6.866.

The application of the logarithmetic diagram to these calculations and to propeller problems is explained in detail in the paper, a full comprehension of which can be gained only by consulting the numerous diagrams which accompany the paper and which cannot be reproduced in the limited space available for this report.

No. 13—Tool Steel for the U. S. Navy

BY LEWIS HOBART KENNEY, B. S., M. E.

ABSTRACT

Previous to 1909 each navy yard prepared requisitions for the purchase of tool steels for its own purposes. The requisitions specified either proprietary material or that the contract would be awarded from information obtained by a test of some description of samples submitted by the bidders. By this method there was no uniformity in the specifications of the navy yards. In order to centralize the purchase and standardize the tool steels for the navy yards, a tool steel board in 1909 recommended that the Philadelphia navy yard be the purchasing station, and prepared specifications for one "high-speed" and three carbon tool steels.

The chemical composition of the "high-speed" tool steel differed from any of the commercial tool steels, and the carbon tool steels were varied principally in the carbon content, in order to adapt them to the purposes for which such tool steels are generally used. The contracts were awarded under these specifications to the lowest responsible bidders for tool steels of a chemical composition within the specification limits. As part of the inspection for acceptance of the material physical tests were prescribed in addition to the chemical analyses, but the physical tests never gave satisfactory or decisive results, and evidently were not co-ordinate with the chemical compositions. The specifications did not provide a means for either ascertaining the relative merits of the tool steels offered by the bidders or if there were better tool steels than those within the limits of the chemical compositions specified.

It was, therefore, considered advisable to revise the specifications so that the bidders would be required to submit samples of the tool steels covered by their bids. The samples would be manufactured into tools, and subjected to physical tests devised to investigate the relative merits of the samples submitted. The data thus obtained would form the basis for recommending the award of contract. The chemical compositions would be given with maximum and minimum limits, in order to indicate to the bidder the kind of tool steel required, but as the physical test would form the basis for recommending the award of contract a statement would be included to the effect that the bidders could submit samples of chemical compositions differing from those specified. The object of this provision was to introduce competition as to the qualities of the total steels instead of simply competition in price.

By modifying the specifications as outlined above a means would be provided for learning something of the relative merits of the commercial tool steels, and for taking advantage of the developments and progress made by the manufacturers in this subject. Definite information would also be obtained of the qualities of the tool steels before the contract was awarded for their purchase, which is evidently a decidedly important matter.

The study of tool steels, which the adoption of specifications as outlined above made possible, is under the direction of the Engineer Officer, Navy Yard, Philadelphia, Pa. The subject practically divides into the two general classifications of "high-speed" tool steel, or tungsten tool steel, Class 1, as it has been designated in the later specifications, and carbon tool steels. The "high-speed" tool steel was considered the more important, and its study was, therefore, undertaken first. The paper has been divided into the following sections:

(*a*) Tungsten tool steel, Class 1, development of specifications.

(*b*) Carbon tool steels, development of specifications.

(*c*) Description of selective tests.

(*d*) General notes.

Sections (*a*) and (*b*) have been subdivided to represent the successive schedules under which tool steels were purchased.

Each of these sections is discussed in detail and amplified with lengthy appendices and numerous charts, showing what has been accomplished in this important department of naval work. When the Philadelphia navy yard was selected as the purchasing station for tool steels, there was no information on file as to the dimensions or amounts of the several kinds of tool steels which would be needed by the navy yards per annum. Tool steels were, therefore, purchased under the specifications then in force from time to time as required. This method required advertising for bids at intervals and caused delays in delivering to a navy yard the tool steel it had ordered.

The expense of a selective test as described in the paper would be prohibitive if it were to be made to determine the award of contract for small quantities of tool steel. It was therefore decided to recommend the purchase of a six months' supply of tool steels in order to test the specifications, reduce the ratio of the cost for the selective test and the cost for the entire amount of steel purchased to a minimum and to get a stock in store.

The selective test, as adopted, indicated that only minor

modifications of the specifications were necessary, and it was therefore considered safe to recommend that an annual contract for tool steels be made, the contract to be so framed that tool steels of any reasonable dimensions and in accordance with the classification of the specifications could be ordered in any desired quantities throughout a fiscal year. A schedule was prepared to meet these requirements, and an extract made from it is given in the paper to explain the general scheme.

No. 14—The Sperry Gyro=Compass in Service

BY LIEUT. R. E. GILLMOR, U. S. N.

ABSTRACT

To be in service an instrument such as that with which the paper deals must have passed the experimental stage—the stage of trial and development. It must have emerged from that stage in a form which is fundamentally sound and practicable. It must have demonstrated its value and have been placed in actual service. This has all come to pass and the old approximate, magnetic compass, with its many errors and weaknesses, is being superseded by an accurate instrument which gives us our true course at sea, is unaffected by magnetic or physical forces tending to deviate it; is simple and substantial, requiring little care or supervision.

Early in this work the inventor became convinced that the major problem was one of pure engineering in devising a suspension which would be frictionless about the vertical axis, allowing the gyroscope to turn with perfect freedom in its effort to seek the meridian. In the most powerful gyroscopic compass which has ever been devised, the maximum directive force (axis at 90 degrees from the meridian) exerts a power which is equivalent to only .015 watt-seconds. This decreases in proportion to the cosine of the angle which the axis makes with the meridian until, when the axis is exactly on the meridian, the directive force is zero. The suspension must be such that the gyro is free to return to the meridian under the very minute directive force exerted when the axis has left the meridian by only a small fraction of a degree. The solution of this problem alone involved years of experimental work, inasmuch as no ordinary suspension could be used because of the weights involved. The problem was finally solved by suspending the gyroscopic, or sensitive element, from a stranded wire, the top of which is carried in a frame surrounding the gyroscopic element, this frame being oriented by an electrical follow-up system in such manner as to cause the frame to follow any tendencies of the gyroscopic element to move about the vertical axis. This constitutes a highly frictionless suspension, with the result that, while great power is available for driving the compass card and repeater transmitting system, the gyro itself has extremely little work to do, and consequently can be made very sensitive while running at quite moderate speed. This suspension has made possible a durable and, at the same time, a very sensitive instrument. Numerous other problems, quite as difficult of solution, were encountered. The manner in which all of these problems were solved, resulting in a strong and accurate instrument, is explained in the paper by a detailed description of the gyro compass as it is constructed at the present time. With the gyro compass it will be possible to navigate the ship accurately in any sort of weather and without taking observations to check the position. Observations would, of course, be taken in good weather as an additional safeguard. The installation of the instrument involves nothing complicated, inasmuch as the only adjustment necessary is to properly place the lubber's point so that the true angular position of the ship's head is always shown.

The first compass was installed on board the Old Dominion Line steamer *Princess Anne*. It was placed at the farthest possible point from the ship's metacenter, so as to obtain the maximum effect from the rolling and pitching of the vessel. A voyage was made with the compass from New York to Norfolk and return. During this time the ship rolled as much as 26 degrees on each side of an even keel. Close observation of the compass failed to disclose the slightest deviation due to this motion. Tests were made by quickly changing course and speed to ascertain whether or not any oscillations were induced by the acceleration pressures so impressed. Following these trials installations were made on the U. S. S. *Drayton,* a torpedo boat destroyer, and on the U. S. S. *Delaware,* a battleship. The satisfactory performance of these installations resulted in a contract for supplying the navy with eight complete gyro-compass outfits. These were installed on board the U. S. S. *North Dakota, Florida, Utah, Michigan, Arkansas* and *Wyoming,* and on the submarines *E*-1 and *E*-2, and since then ten more compasses have been contracted for.

A Tribute to the Titanic Heroes

In his address, delivered at the twentieth annual meeting of the Society of Naval Architects and Marine Engineers, Mr. Stevenson Taylor, president of the society, paid the following tribute to the brave men in the engine room of the *Titanic:*

"The one overwhelming event of the year, which more than any other directly interests naval architects and marine engineers, was the loss in April last, with its awful consequence, of the splendid *Titanic,* the latest work of one of the great shipbuilding yards of the world. No previous disaster at sea, great as some have been, ever produced the consternation and appalling feeling of man's impotence that was caused by the foundering of what was considered the last word in ocean steamship construction. This terrible event has been the occasion of investigation at home and abroad, with sundry conclusions as to the responsibility for the disaster and the need of changes in the various requirements for the future. All naval architects are aware of all that has been said and done, for a matter of such vital interest to everybody must have received from every member of the Society of Naval Architects and Marine Engineers the closest attention and most careful consideration. The disaster has been attributed, perhaps, to a combination of circumstances never happening before, in which combination occurs human judgment, upon which, in all walks of life, in all spheres of action, so much must depend. Where human judgment is concerned a tribute must be paid to those in the engine rooms at the time of the disaster. In our work we meet and know this class of men. Far below in the depths of the ship they well knew long before those on deck of the fatal hurt the ship had received. Of those directly employed by the steamship company who were called to their places as a matter of regular duty, and of those on assumed duty in behalf of the builders, who were at the time in no way responsible for the management of the ship, not one was saved. There were many glorious examples of heroism on deck, but none more glorious, none showing greater self-sacrifice than the example given by that splendid engineer corps, remaining below awaiting the end without the slightest possible chance of life. All honor to those true, brave men!"

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The American Society of Mechanical Engineers will meet with the Verein Deutscher Ingenieure in Germany, June 21-July 7, 1913. Members and guests of the American society will leave New York June 11, and the itinerary as planned offers a most remarkable tour of the industries of Germany.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

The Engineer—Marine or Stationary?

For the young man who wishes to become an engineer it is sometimes difficult to decide which course he will pursue, whether to become a stationary engineer or a marine engineer. When he is in doubt opportunity and circumstances often decide the question for him, but nevertheless much has been written regarding the advantages and disadvantages of each, and the beginner naturally wants to know which course is preferable and why.

In large power stations may be found many engineers who have followed the sea and hold a marine license; also from chief engineers of power stations it has been ascertained that the marine engineer is much in demand on shore, the reason for this being that the engineer who follows the sea in ships of large tonnage, especially in the large express steamers, has a greater variety of duties to perform with which the engineer on shore never comes in contact. The chief engineer who is a marine man is schooled in discipline as well as in mechanics. He learns discipline while holding a subordinate position, perhaps as third assistant engineer, where he must direct successfully men who are not ambitious but who are simply a part of the human machinery of the engine department, This is sometimes a difficult task and requires much patience and persistence which is not known to the stationary engineer. The men in the engine department on board ship are there to work and perform the duties for which they were shipped. The engineer at sea cannot tell a fireman that he is discharged —nothing of the kind can be done. The fireman is there to work and complete the voyage, unless he is physically indisposed, and in such an instance it should be noted that the ship's surgeon is not an "easy mark" by any means, and if a case of sickness is found to be false the "knight of the coal shovel" will soon find himself back at his furnace doing the bidding of the third assistant engineer.

"All is not gold that glitters." The young man who looks on the shining cylinder heads of a marine engine knows nothing of the dirt in the bilge, nor has he felt the roll of the ship or the pitching in a head sea, or the nauseating smell of hot, burning engine oil dripping from a steam pipe until he has come in contact with it. Hot water and bare steam pipes are a constant source of worry and disgust to him, and he will probably soon be strongly tempted, as the boys say, "to chuck up" his job. But on reaching port and smooth water again he decides to try one more trip, and thus he gets the fever, and then the habit, and it is hard to get away once you have become acquainted with the Old Man Neptune, for he has a hold which it is hard to break. At sea your meals are regular and, although your work is hard, you have a good appetite, which, of course, is not saying that your appetite is always satisfied; but, nevertheless, plain food and plenty of it does wonders for the ambitious young man.

The chief engineer of one of the Sound steamers of the Fall River Line was asked for his opinion as to which was preferable, an engineer's life on shore or afloat, and his prompt reply was "an engineer's life on shore is preferable. A man on shore in a large plant has a much better position." Being asked as to why this was so, he gave many and various reasons, one being that it was worth more money, which, of course, would rule the majority. But the young man who is interested in his work leaves this as a secondary consideration; for in his earlier years knowledge and practical experience are, or should be, what he is after. Much of this he can obtain by keen observation and a sensible question asked now and then. Generally the desired information is cheerfully given, and then, again, sometimes you don't get it. Some of the old school engineers think the young fellows are too progressive, and, in a certain light, they look dangerous, but, on the whole, you will find marine engineers to be a fine class of men and conscientious to a point almost unbelievable.

Marine engineering is a combination of theory and practice, and to follow it successfully requires much study and planning, and a man should read much in his spare time and compare notes with the fellow on the other boat. The man who does not read, does not progress. He is at a standstill and just performs the routine duties of his position, and nine times out of ten his hand never reaches the pen in the office of the local inspector who issues the marine engineer's license.

The young man who wishes to go to sea and become a marine engineer, unless he is far-sighted, may think it will be a humdrum life, but, as a matter of fact, there is something to look ahead for. The marine engineer may not always follow the sea; and if he gains a reputation for sobriety, trustworthiness, and is an economical man and a good mechanic, and maintains good discipline, many good positions are open to him on shore; for the training he has received on shipboard is quite an asset to the corporation which desires his service. The marine engineer must depend on his own ingenuity many times for temporary repairs, whereas his brother on shore can have parts repaired or refitted for him without worrying much about it. Of course, he is directly responsible for the repair work, but the repair man usually furnishes the tools and does the work in the usual way. Also, there is usually a machine shop around the corner, and the repair work is not such a tax on the engineer's ability as it would be at sea, where he has to depend largely upon his own resources.

Opinions regarding the qualifications of a successful engineer have changed greatly in the last few years. It used to be thought that the chief engineer should be quite an old chap with years of practical experience, and theory did not count for much. A very interesting illustration of this occurred recently to a young man who applied at a sawmill in one of the Northern New England States for a position as engineer. He was told that he was too young and had not had enough experience. Much humiliated he went away, but the next year he happened to be in that vicinity again and he thought he would see what kind of a man was holding the position. He found that the present incumbent was quite an old gentleman with a strong resemblance to Santa Claus. He had a long white beard and was considered by the superintendent to be an engineer of unsual ability. The young man remarked to the venerable engineer with the whiskers of great length that the last time he was in that place the engine was turning to the right, but that this time she was turning under or to the left with the belt crossed. In explaining this unusual occurrence the old engineer remarked that the engine had started the wrong way one morning, and being unable to determine the cause for this they had crossed the belt, and, outside of a large-size bump, she was running first rate. Poor old chap! Who knows but that perhaps some morning he will start the engine up and perhaps the eccentric will slip just enough to start her the other way, or perhaps she won't go at all From

this it may be readily seen that the time served and the experience and practical knowledge gained differs greatly with men.

The young engineer should train his powers of observation and keep a memorandum book with examples and facts correctly written therein, which will be of great assistance to him many times. The best preparatory school for the engineer, whether he is inclined to adopt the stationary or marine practice, is the engine-building shop. Isaac N. Cory.

New Bedford, Mass.

A Word as to Boilers

It is true in many cases that no part of marine machinery receives more abuse than the steam generator. In placing a contract the owner will try to get as cheap a job as possible, never considering that during the remainder of the plant's life he will spend large sums for fuel, and perhaps for large repair bills. Go on board many ships and take a look at the boilers. In numerous cases we see a state of affairs that is absolutely startling. What is there to keep oil and grease out of the boilers? At what temperature does the feed-water enter the boiler? The writer some few years ago examined a boiler of a coastwise ship. This boiler was of the leg type, and had he been told that it was coated with grease he would not have believed it. As a matter of fact, however, the boiler was worse than coated. The stays were covered with a nice, thick coating of grease, which was well baked on. On the back connection, on the crown sheets—in fact, on every place one could see—there were signs of oil, and he wondered that it ever kept together and that there never was a loss of life and floating property.

Some time ago a large ocean-going tug was fitted with a new boiler. At the time the boiler was being built repairs were also made to the machinery, and in the latter was the reboring of the high-pressure cylinder. This tug was fitted with a heater and grease extractor. After the tug was in commission complaints were made regarding the coal consumption. An investigation showed that the grease extractor was not used. The heater coils were covered with grease, and the boiler was thoroughly saturated with grease and oil. Upon seeking a reason I found that the engineer had no time to renew the cartridge and he had been using great quantities of oil in his high-pressure cylinder.

Now, there are ships running that have no grease extractor, and many are without heaters, distillers or evaporators. The reason for this is simply the question of first cost. Yet many times the price of these outfits is paid for in the saving on coal bills, and that in a comparatively short time. What is the cost of a grease extractor compared to the cost of a furnace, plus the loss occasioned by a tie-up? It is not my purpose to talk feed heaters, grease extractors or other specialties. I am, however, at a loss to understand how owners can ignore this vital part of a ship's plant. Aside from the enormous loss of efficiency as a steam generator caused by grease and oil by the introduction of feed at a low temperature, enormous strains are put up in the structure, and often cause trouble, which likewise is very costly. We know that distilled water is not good for a boiler, and to avoid any trouble we simply use enough salt feed to give the boiler a fine coating of salt. It is a very poor plan, indeed, to use oil in the cylinder of a new engine, and it should be worked without it. There will, however, be a very slight amount of oil introduced into the cylinders, especially in the low-pressure cylinder, from the swabbing of rods.

There is not to-day a grease extractor that will take all the oil out of feed-water. Oil can only be entirely eliminated by taking it out of the steam. If we had a grease or oil extractor placed in the eduction pipe we could practically eliminate all the oil. Take, for example, a piece of plate, say No. 16 B. W. G., and form it so that it will hold a small quantity of water. Before introducing the water smear a portion of the surface of plate with a small quantity of oil; then introduce the water, place the plate over a candle, and note what takes place. It is a very interesting sight, and one would be surprised to see what happens. Further, we can readily understand why crown sheets come down.

A well-made boiler is a dependable thing, and when properly proportioned and designed, as well as properly handled in service, is capable of showing very high efficiency. It matters not, however, how well designed or built if its treatment in service is bad. A man will pay thousands of dollars for a race horse, and he sees to it that his animal is treated with the greatest care and that everything conducive to its longevity is obtained. Why? Because it is a source of revenue. Yet a boiler, costing more, and being even a greater source of revenue, is permitted to be handled by ignorant attendants, and anything conducive to increased efficiency is considered too costly to install. Think of the boilers to-day on so-called modern ships, let alone in stationary plants, which are treated to a good surface blow every day to get rid of the oil and scum carried over from the use of oil in the engine! Is this heat worth saving? Does it not represent money? Does it not represent energy going to waste? Does it not denote terrific strains on the boiler itself? Does it not show lack of appreciation of cause and effect? The answer may be that we have not enough auxiliaries to heat the feed. Yes, that may be true enough, and theoretically there is no gain by heating feed-water with steam direct from the boiler, and a little thought will make the reason clear; but there is a gain, a vast gain, in the life of boiler, because the strains are eliminated. If the strains put up were constant and not intermittent in character, they would not be so dangerous; but is it fair to suppose that intermittent stresses are set up and no injurious effects follow? I do not think so. These are abuses that can be remedied, and should be, aside from the question of fuel economy. It requires the closest contact between the gases and the walls of the boiler and between the wall and the water for efficient transmission of heat from the gases of combustion to the water. If this condition must obtain, then we will have to keep all foreign matter out of our boilers. We all know that the most efficient heating surface is that of the furnace crowns and combustion chambers, this being, of course, due to the difference of temperature between the two sides of the plate. Then there is freedom of the surfaces from deposits of soot or ash, and if proper precaution is taken freedom from mineral or earthy matter.

Now, as for the remaining parts adding to heating surface, we can eliminate them in the present article, as the above-mentioned surfaces are those affected by grease and oil. If I could picture the condition of some boilers which I have examined internally, I am sure it would hardly be credited. Yet the fact remains that such conditions did obtain and still obtain, and many boilers are filthy and the line of oil marks are clearly shown. At one time in the history of the steam engine, I will grant, cylinder lubrication was a necessity, and the old grease cup on the top of cylinder heads was considered a thing of beauty and a joy forever for the engineer. In the present-day conditions it is not necessary. If kerosene (paraffin) is at times introduced into the boiler it not only insures a harmless lubricant but at the same time a most efficient one, as the cylinders and the surface of cylinder walls soon take on a magnificent polish, and, again, there is a chemical action which hardens the surface, and in a period of time the walls reflect like a mirror.

What is the gain by using a feed-water heater? Let us first suppose that the water is fed to the boiler at a temperature of 110 degrees, and, further, that the working pressure

is 180 pounds gage or 195 pounds absolute. We will assume that 8 pounds of water are evaporated under these conditions per pound of coal. The total heat of steam at a pressure of 195 pounds absolute is 1197.5 British thermal units per pound. The temperature of the feed-water being 110 degrees we have 1197.5 — (110 — 32) equals 1119.5 British thermal units added to each pound of water passing through the boiler. Now, as 8 pounds of water are evaporated per pound of coal, we have 8 × 1119.5 equals 8956.0 British thermal units. Now suppose a heater is installed and our feed-water is to be raised to 212 degrees. To generate steam of 195 pounds absolute pressure from a feed of 212 degrees requires 1013 British thermal units, which is made up of the latent heat (845 British thermal units) plus 168 British thermal units, the sensible heat (168 British thermal units). We therefore have 8956 British thermal units, divided by 1013 British thermal units equals 8.84 pounds, or a gain of 10.5 percent. It is the practice, however, to heat the feed to 215 degrees and 220 degrees F., resulting in a gain of about 10.5 to 11 percent. It is unnecessary to carry this further.

Is it worth saving? Is the life of the boiler worth prolonging? Is the boiler to be credited with low efficiency because it receives but scant consideration? Is the engine to receive every consideration, while the steam generating plant is passed over with only sufficient interest to warrant the production of sufficient steam to enable the engine to turn the wheels and thus propel the floating body?

We are in latitudes where the coal pile is getting to be of some consequence, and where the boilers have to receive some scientific consideration. There is plenty of room for improvement in design, and there must be a more scientific method of handling when under way. There is no excuse for having dirty boilers, nor is there any excuse for having crown-sheet trouble caused by grease. It would take more space than can be given in this article to compare the cost of prevention and the cost of new furnaces. It would, however, be an interesting comparison.

I cannot close this without mentioning a case that came under my notice about three years ago. I was requested to go South and at a certain point meet a large ocean-going tug, bring her to Baltimore, and there make a complete examination and report, as on my report the boat would either be accepted or rejected. After the boilers had cooled down I went through them, and never inspected more finely-kept boilers; there was not a trace of grease in any part, the water-line was a well defined line, and I could take my fingers and erase all sign of it. It was properly coated with salt, just enough to prevent any injurious action of the water. The steam space was perfect, and one could have gone in those boilers without getting his clothes soiled, as the deposit of salt would brush off. There was no sign of pits; and, furthermore, no damp ash was allowed to accumulate around the front, and therefore no corrosion due to this cause was able to take place. The boilers, at that time, had been three years in actual, hard service. There was no indication of any part being strained; furthermore, there was not a sign of a leak of any kind. These boilers were built by the Harlan & Hollingsworth Corporation, Wilmington, Del., and were characteristic of their boiler work.

I have not since or do I ever expect to see finer treatment given boilers than these received, and the efficiency was very high. I had the pleasure of seeing a boiler plant a few days ago where the boilers receive first consideration, and here were boilers furnishing steam to a triple-expansion engine and the necessary auxiliaries; the feed temperature is held at 215 degrees F. The efficiency of this plant, taken from log entries, is very high, and I may say the thermal efficiency of the engines is likewise high; in fact, higher than that which ordinarily obtains. I can mention several ships of this line that show very high evaporative efficiency and where the boilers are the first consideration, and the superintending engineer, as long as I can remember, has been considered a crank on the boiler question, but results have amply justified his demands that the boilers receive certain proper treatment, and for the size of their ships they are the most economical and efficient.

We can design and construct, and on these points we can exercise judgment and produce a fine piece of work. In actual operation, however, we have no control, and it matters not how we design to satisfy all conditions of stress and strain; if the necessary precautions are not taken and the required preventatives adopted the boiler will not, and cannot, be efficient, and above all the attendants must be instructed and made to handle the boilers in a more scientific manner. Sludge, grease, excessive strains, and leaks caused by them, can be eliminated, dropped crowns can be likewise eliminated and money saved. It is up to the owner whether he wants dividends from every item of his plant or is satisfied to pay coal bills and tries to "grind" down builders in the cost of construction. The latter is the spigot, the former the bung-hole, and let us ease up a little on the poor spigot and get after this bung-hole, which is very much larger.

New York. CHARLES S. LINCH.

Duplex Pumps

A steamer in which the writer served as third engineer had a duplex ballast donkey with which the chief expressed himself as very dissatisfied.

The pump in question was overhauled and apparently worked fairly well, but the chief seemed to have a grudge against it. He was always complaining that it did not work correctly. Finally he tried a new method of his own to adjust the valves. While steam was on the pump he uncoupled the valve links and gave the valve rod half a turn, opening the valve to steam to see the effect, repeating the dose at his discretion. The looked-for happened after a while; to the great amusement of us juniors he miscounted his turns and carried away the link motion altogether.

It is my opinion that the majority of my seagoing colleagues do not understand the mechanism of the duplex pump. It gets the hardest service, any amount of abuse and no thanks. It puts up with treatment that would put out of commission any other engine room auxiliary. Space and price considered it earns its keep handsomely. My experience may be unusual, but no engineer I was ever shipmates with really understood the duplex pump, and it is with this in my mind that I write. It was my good fortune to come across two men at different times who had made a life study of pumps, and for the benefit of the large number of my colleagues who have not had this good fortune I wish to pass on to them the results of my tuition.

TO SET THE VALVES OF A DUPLEX PUMP

(1) Set both piston rods in mid position. To do this force the piston rod one side of the pump, using the cross-head and not the links until a satisfactory bump is obtained on the cover by the piston; mark the rod by scribing from the face of the stuffing-box. Now bump the other end of the cylinder, and by measurement obtain the distance between the first mark and the stuffing-box face. Now make a mark on the rod in the center position between the two, and set the rod back until this comes at the stuffing-box face.

(2) Repeat with the other rod. Lift the valve covers and examine the valves.

(3) If the pump is small there is a single nut in the center of the valve, which is not a fit, the valve having lost motion or back lash. Try the valve to both ends of extreme movement; it should then uncover an equal amount of port opening. If

not, adjust to suit. I may state that in every case where I have opened up a duplex pump in a ship I find the lost motion carefully washered up.

(4) If the pump is of larger type the valve rod has double-lock nuts on either side of the valve, and I have invariably found these tight up to the valve. Lost motion must be given to the extent of 3/16 or ¼ inch, dividing the port opening equally between the extreme positions of the valve.

There is no outside lap on the slide valve of a duplex pump, and the lost motion compensates for this. Too much lost motion will cause the pistons to knock on the covers; too little shortens the stroke. Duplex vacuum pumps used for pumping hot water have lost motion visible outside the valve chest, the coupling of valve rod to its link having a connector which allows a limited amount of lost motion. The latter can be varied at pleasure by stopping the pump and adjusting the screw connector. When pumping hot water the lost motion is adjusted to suit varying temperature.

Testing of Duplex Pumps

Screw a pressure gage on the steam end and another on the water end of the pump. It will be found that there are tapped holes for the purpose in the covers.

Ascertain by the steam gage that the pump is getting full steam pressure; throttle the delivery valve on the pump until equal pressure is obtained on the water gage; open the air cock to relieve air, and steady pointers of gages by the cocks It is better to disconnect the delivery of the pump, letting the water run into the bilges, but a valve must be on the delivery of the pump. The pump should deliver full bore of water at a fair speed. Test now for low steam pressures as well as high. Satisfaction on this point having been obtained try the pump with, say, 60 pounds of steam, and throttle the delivery until the pump slows down to about eight strokes a minute. Carefully note the behavior of the gage on the water end. If the pointer remains at a reasonable constant pressure, the pump taking a full-length steady stroke as well as giving a clear exhaust cut-off, there is little or no fault.

Should, however, the gage indicate excessive ranges of pressure, with either side working with a quick return (though taking full stroke), it indicates leaky water valves as follows:

(1) Either through improper facing.

(2) A seat being loose.

(3) A valve hung up, either by fouling the side of the chamber or a foreign substance lodged between the valve and seat.

A pump working erratic and taking short strokes may be due to one of the following defects:

(1) Joints blown between the two steam cylinders, thus allowing pressure to be on the back ends of both pistons at the same time.

(2) By leaky steam pistons, allowing live steam to be on both ends of the pistons at the same time.

Either defect could be detected by throttling the delivery valve, thus slowing up the speed of the pump. The presence of live steam through the exhaust would then be plainly apparent.

Leaky water pistons or a broken joint beneath the force plate or water chamber covers will render the working of the pump erratic in some instances. But when the joint does not blow until the higher pressure is reached the gage on same would serve as an index to the trouble, it being difficult to raise the water pressure beyond a certain limit, notwithstanding the speed of the pump being increased. Under these conditions the pump would deliver but a small percentage of its plunger displacement against pressure.

The foregoing remarks on testing refer to boiler feed pumps especially, and if the test is carefully carried out will obviate the nuisance of a breakdown where a duplex pump is fitted for boiler feeding.

To test for vacuum, a vacuum gage should be fitted between a valve in the suction pipe and the pump. By adjusting the valve the vacuum gage will indicate on this point. Twenty-seven inches of vacuum should be obtained with no difficulty, and this also serves when the pump is fitted to test lightness of suction pipes. The vacuum test has, of course, its greatest value where duplex pumps are used as ballast donkey pumps and for bilges.

A. L. Haas.

London.

Bulk Cargo Steamship Frieda

There was launched on Oct. 29, from the yards of the Fore River Shipbuilding Company, at Quincy, Mass., the bulk cargo steamer *Frieda*, to the order of the Union Sulphur Company. The vessel was christened by Miss Adeline N. Snider, daughter of Mr. Clarence N. Snider, the treasurer of the Union Sulphur Company.

This vessel is 315 feet in length and of 5,000 tons deadweight on a moderate draft. The *Frieda* has been designed especially for the transport of bulk cargoes of low density, and for this reason there has been incorporated in her hull topside and also athwartship ballast tanks, making the holds self-trimming on all four sides, thereby more than doubling her ballast capacity and reducing her tonnage 20 percent.

The hull has been built to the highest class in Lloyd's Register, on what is known as modified transverse framing. The vessel is of the single deck, poop, bridge and forecastle type with propelling machinery installed aft, and is rigged with three pole masts, the fore and main having derricks and cargo discharging gear.

The accommodations comprise separate staterooms for the captain and navigating officers, together with two guests' rooms in the bridge house amidships. The engineers are quartered in a commodious Liverpool house on the poop deck, and the petty officers, seamen, wipers, etc., in wing houses at the forward end of the poop deck. These accommodations will be exceptionally comfortable and go far to establish the superiority of the quarters allotted to American seamen.

The auxiliary machinery comprises a Hyde windlass and steam capstan, Lidgerwood winches and steam steering gear with telemotor. There are a submarine signal, wireless telegraph installation, Morse night signal and a porhydrometer for the automatic weighing of the cargo.

The propelling machinery consists of a 22½-inch triple expansion engine with two large single-ended Scotch boilers with Howden's forced draft and fitted for burning liquid fuel. There have been installed in the engine room duplicate sets of 10 kilowatt generators; also two half-ton capacity ice machines to take care of the crew's consumable stores.

Altogether the vessel will prove a noteworthy addition to the owner's fleet, and it is hoped it will maintain the high tradition of her builders as exemplified in the steamship *Herman Frasch*, constructed at the Fore River Shipbuilding Company's yards at Quincy, Mass., over two years ago for the same owners.

German Naval Programme.—The new German naval construction programme provides for one battleship and one large cruiser each year from 1912 to 1917, with the addition of another battleship in 1913 and 1916.

Oil Fuel in the Navy.—During 1911 the United States navy used 15,000,000 gallons of fuel oil. The consumption for 1912 was estimated at 21,000,000 gallons.

Review of Important Marine Articles in the Engineering Press

H. M. Torpedo Boat Destroyer Lurcher.—The *Lurcher,* one of the *Firedrake* type, obtained during an official full-speed trial of eight hours a mean speed of 35.345 knots, or 3.345 knots in excess of the contract speed. The trial was run in deep water. The boat is 255 feet long with a beam of 25 feet 7 inches, and is propelled by twin screws driven by Parsons turbines, steam being supplied by three of the latest type of Yarrow boilers arranged for burning oil fuel only. Illustrated. 250 words.—*Engineering,* September 27.

The Diesel-Engined Ship Fordoman.—The motor ship *Fordoman,* of 2,368 gross tons, 250 feet long by 42 feet 6 inches beam by 26 feet 6 inches depth, has been built by the Clyde Engineering & Shipbuilding Company, Port Glasgow, for the grain-carrying trade on the Canadian Great Lakes. The propelling machinery consists of a four-cylinder set of Carels two-stroke-cycle Diesel engines, with cylinder diameters 18⅛ inches and stroke 32¼ inches, designed to develop 750 brake-horsepower at a normal speed of 120 revolutions per minute. On trial the designed speed of 10 knots was exceeded, the fuel consumption being .47 pound per brake-horsepower per hour throughout. Exceptional results were also obtained in maneuvering, as 63 reversals were accomplished in 42 minutes, and at the end of the trial more than half of the stored compressed air was still available. A complete reversal from full speed ahead to full speed astern occupied six seconds, and the engines were stopped dead from full speed in three revolutions. 250 words.—*Engineering,* September 27.

Deckloads of Lumber.—By Arthur R. Liddell. The fallacy of the British law regarding deckloads of lumber is pointed out, and in a discussion of the sea-going qualities of a lumber steamer loaded with a deckload, the proper disposal of deck cargo for safety in ships of different design is explained. 1,700 words.—*The Marine Review,* October.

Submarine Torpedo Boat Seal.—The *Seal* is the first submarine of her type to be built for the United States navy. She was constructed by the Lake Torpedo Boat Company, Bridgeport, Conn., and recently completed her acceptance trials off Provincetown, Mass. The arrangement of torpedoes in this boat is unique. Besides the ordinary bow tubes there are also deck torpedoes carried in revolving torpedo tubes in a superstructure, so that they may be trained to either broadside as any ships' guns. In her trials the boat made a surface speed of 14.7 knots and a submerged speed of nearly 11 knots. She was submerged to a depth of 256 feet with the crew on board, which is a record in the performance of submarines. One photograph. 700 words.—*The Marine Review,* October.

The Commercial Prospects of the Marine Oil Engine.—It is pointed out in this editorial discussion that while there is every promise of the mechanical success of the marine oil engine, the problem as a commercial one is more complex. The remarks of Sir Charles Parsons, in his presidential address delivered to the Northeast Coast Institution of Engineers and Shipbuilders recently, are commented upon freely, as his address was a masterly survey of contemporaneous progress towards economy in marine propulsion. According to the information presented in this way it is evident that by no possibility could oil displace coal for all purposes, and that if there is not a great development in the output of oil the progress of the marine oil engine must suffer. A comparison of the relative costs of different fuels, as supplied by Mr. C. E. Stromeyer in his annual report as chief engineer of the Manchester Steam Users' Association, is also quoted, showing that at $3.60 (15s.) per ton for coal, oil would have to be at $12.50 (50s.) for equality. The disadvantages of oil engines, apart from the cost of fuel, were also discussed, as well as the possible increase of efficiency of marine steam machinery. While the possibilities of a gas turbine are not counted as particularly hopeful by Sir Charles Parsons, yet the possibility of a semi-rotary engine in its place is set forth for a future development of internal-combustion engines. 2,500 words.—*Engineering,* November 1.

Developments in Battleship Design.—The various stages of development of battleship design in the British navy from the *Dreadnought* to the *Iron Duke* and *Marlborough* (recently launched) are traced. Little is known regarding the details of the last two vessels except that they are 580 feet long, 90 feet beam, with a displacement of 25,000 tons. The primary armament consists of ten 13.5-inch guns, the position of the guns in the ship corresponding generally with that evolved for the *Orion.* The secondary battery in these vessels consists of 6-inch guns mounted behind broadside armor on each side of the ship. The extent of the armor protection has not been disclosed, but undoubtedly it is increased both in thickness and extent over that in previous battleships. The speed of the new vessels remains at 21 knots, power being developed on four shafts from turbine engines operating at about 300 to 320 revolutions per minute. The power is increased from 23,000 in the *Dreadnought* to 29,000 in the new ships. Thus while the tonnage has increased by 40 percent the designed horsepower has increased only by 20 percent. 1,250 words.—*Engineering,* October 11.

German Motor Notes.—From observations made on a visit to the principal marine engine builders in Germany it was found that in that country there are seven firms which are actually building heavy oil marine motors of considerable size. These firms are Blohm & Voss, Hamburg; The Reiherstieg Shipbuilding Company, Hamburg; Fried Krupp, Kiel; A. G. "Weser," Bremen; J. C. Tecklenborg A. G., Geestemünde; J. Frerichs & Company A. G., Osterholz-Scharmbeck, and the Maschinenfabrik Augsberg Nuremberg, Nuremberg. Of the firms mentioned, Maschinenfabrik Augsberg Nuremberg and Krupp already have engines at work on submarines and for small craft. Frerichs also have installed engines on some small fishing craft. The others are not as yet represented afloat, although progress on work in the shops in building motors of large units is well advanced. Generally speaking, all these engines are the outcome of considerable experience on a smaller scale. All firms are building two-cycle engines. Reiherstieg and Tecklenborg are building motors after Carels designs. Krupp and Blohm & Voss are working with Maschinenfabrik Augsberg Nuremberg, while the Weser and Frerichs companies are working on quite a different line, building engines according to Professor Junker's patterns. The most remarkable feature noted in this trip was the progress made with the double-acting engine and the use of tar oil as fuel. The one point upon which unanimity has apparently been reached is in the general design. In all cases it was found that for the larger engines the trunk piston has been abandoned in favor of the cross-head and piston rod, while the entirely open engine is finding increasing favor. In general, the construction of oil motors is being taken up by marine steam engine builders, and the results of many years' sea-going experience has an important influence in the design. The use of compressed air for starting and maneuvering motors seems to be the only available means for this purpose. The driving of auxiliaries is still unsettled. There is also no settled policy with regard to the driving of the scavenging pumps. The general impression recorded from these observa-

tions is that the mechanical aspect of the provision of oil engines suitable for adoption on ships of the type of which some four-fifths of the German steamers of the world consists is to-day a matter of practical politics. Two difficulties only stand in the way: First, the necessary number of engines could not at present be produced from the factories of the world, and, second, a regular supply of fuel at a reasonably cheap rate, say not more than three times the cost of coal, is not yet assured. The notes describe in detail the construction of the different engines inspected, and the notes are profusely illustrated with photographs and line drawings. 14 illustrations. 8,000 words.—*The Engineer*, October 11 and 18.

The Strength of Bulkheads.—The scantlings suitable for a bulkhead depend upon the purpose for which it is fitted. Two cases are considered: First, the end bulkheads of spaces which are to contain water ballast or oil, and, second, the "ordinary" watertight bulkheads which only have to withstand water pressure in case a compartment is accidentally flooded. The first bulkhead is much more rigidly stiffened, while in the second bulkhead the scantlings are much lighter, and the bulkhead does not necessarily prevent considerable deflection or a certain amount of leakage which can be taken care of in an adjacent compartment by the ship's pumps. It is found to be more economical as regards weight of material involved to fit brackets and small-sized stiffeners rather than larger stiffeners with no brackets, and it is now the general practice to fit brackets at the top and bottom of stiffeners at least in the holds and lower 'tween decks. The theoretical treatment of the strength of bulkhead plating is a difficult matter, but the most reliable formulæ for such calculations are thoroughly discussed. A design for "ordinary" bulkheads is proposed, in which the stiffening is furnished on the principle of the more rigid oil-tight bulkheads. It is found that such construction would be more expensive to construct, and would tend to break certain stowage rather more than the arrangement of uniform stiffeners, although it is obvious that if the strengthening of bulkheads is to be increased beyond present practice some sacrifices must be made. 4 illustrations. 2,800 words.—*The Shipbuilder*, November.

Cargo Steamers for Service on the St. Lawrence and Great Lakes of North America.—The size of locks in the canals between Montreal and the Great Lakes necessarily limits the dimensions of the vessels which pass through, consequently a special type of boat, abnormally broad in relation to the length, has been evolved for cargo-carrying on this route. The greatest dimensions which can be conveniently maneuvered through the locks are: Length over all, 259 feet; breadth, extreme, 43 feet 6 inches; draft, 14 feet. The chief features of the design of such vessels are indicated by drawings and the important points in their design are fully treated. It is noted that the use of internal-combustion engines for the propulsion of such vessels has already been tried, offering distinct advantages as regards increased deadweight and cubic capacity. Their future adoption for this service will depend upon their reliability under service conditions. 6 illustrations. 1,200 words.—*The Shipbuilder*, November.

The French Liner Paul Lecat.—This vessel is a twin-screw liner recently completed at La Ciotat for the Compagnie des Messageries Maritimes mail service between Marseilles and China and Japan. She has a length over all of 528 feet, a breadth of 61 feet 9 inches, a displacement, loaded, of 15,100 tons, a draft, loaded, of 24 feet 4 inches, and a designed sea speed of 15 knots. Her gross tonnage is 12,988. Accommodations are provided for 149 first class, 182 second class and 109 third class passengers. Propulsion is by two quadruple expansion engines developing 11,000 indicated horsepower, with cylinders 30½, 43, 62½ and 88½ inches diameter, with a stroke of 53 inches. Steam at 215 pounds pressure is furnished by twelve cylindrical double-ended boilers fitted with Howden's system of forced draft. The total heating surface is 29,000 square feet. The bunkers have a capacity of 1,850 tons. The electrical installation comprises four generating units having a total horsepower of 500. The ship attained a main speed of 17.245 knots on a 40-hour trial, developing only about 10,300 indicated horsepower. A sister ship, to be named the *André Lebon,* for the same service, is now in course of construction at the La Ciotat shipyard. 12 illustrations. 1,000 words.—*The Shipbuilder,* November.

Burbridge Patent Double Davits.—This davit consists of an ordinary round-bar ship's davit with a smaller one attached to it through means of two heavy forged collars. This arrangement permits one set of davits to handle two lifeboats. The upper boat is always suspended from the ordinary davits ready for immediate launching, but before putting it outboard the small davits attached thereto are swung around over the second boat, and the attachment of the second boat to the small davits is carried out while the upper boat is being lowered into the water. No gears are used, but the leverage of one davit swings out the other. 3 illustrations. 800 words.—*The Steamship,* November.

Presidential Address.—By Mr. Summers Hunter. At the October meeting of the Institute of Marine Engineers, Mr. Hunter delivered a lengthy presidential address, discussing first the history of marine steam engineering and then taking up in detail the many developments which have been made recently in ship propulsion. No attempt is made to describe the various types of propulsive machinery, but the results accomplished and the advantages gained in each case are indicated. The internal-combustion engine and the various forms of transmission are treated briefly, as work in this direction is still largely in an experimental stage. Considerable attention is given to the subject of superheating, in which it is pointed out that the ordinary saving derived from the use of superheated steam appears to be 20 percent. Further economy has recently been effected by using superheated steam in quadruple-expansion engines. Other sources of economy have been found by the use of improved air pumps, a better knowledge of the principles of condensation, vacuum, feed-water heating, etc. The success of the Diesel oil engine is treated quite fully, the speaker emphasizing the fact that before this prime mover is extensively adopted further results must be obtained from the actual behavior of the engines as installed in ships under the most severe conditions at sea. The address is concluded by reference to recent improvements in methods of manufacture and the education and training of engineers in the future. 7,500 words.—*Transactions of the Institute of Marine Engineers,* October.

The Spanish Battleship España.—Three battleships, the *España, Alfonso XIII.* and *Jaime I.*, are now under construction in Spain under the direction of the Vickers-Elswick Syndicate. The displacement of the ships is 15,700 tons, the length on waterline, 439½ feet; beam, 78¾ feet, and mean draft, 26 feet. The armament consists of eight 12-inch 50-caliber guns in four twin turrets, and twenty 4-inch guns with four smaller pieces and three submerged torpedo tubes. The big guns are distributed as on the British battle cruiser *Indomitable;* their height above the water is 25 feet, and they are protected by 10-inch armor. The belt armor is 8 inches thick, tapering to 4 inches at the ends. The propelling machinery consists of four sets of Parsons turbines, actuating four screws, the horsepower being 15,500 and the designed speed 19.5 knots. Yarrow boilers are installed, the coal bunker capacity being 900 tons normal and 1,900 tons maximum. 2 illustrations. 1,600 words.—*The Marine Engineer and Naval Architect,* November.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of INTERNATIONAL MARINE ENGINEERING, published monthly at New York, required by the act of August 24, 1912.

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H. L. Aldrich, President and Treasurer.

Sworn to and subscribed before me this 2d day of October, 1912.

(Seal) DAVID FISCHER,

Notary Public.

(My commission expires March 30, 1913.)

The regulations of the Treasury Department promulgated under the provisions of Section 5 of the Panama Canal Act relating to the free entry of shipbuilding materials and equipment have just been completed, and will soon be available in printed form to those interested. The following is a memorandum of the principal features of these regulations:

1. A vessel will be defined as any water craft entitled to be documented under the laws of the United States and similar craft for which there are no such requirements, such as battleships, revenue cutters and governmental vessels. This will include every vessel of over 5 tons, whether used by the Government or for commerce or pleasure.

2. Machinery will not be entitled to free entry. Included in the term "machinery" will be auxiliary machinery, such as pumps, steam winches, hoisting engines, electric motors, and generators, condensers, etc.

3. The term "outfit and equipment" will be defined as including all portable articles not permanently incorporated in the hull or machinery, and will include rigging, tackle, boats, life-saving apparatus, wireless apparatus, searchlights, lamps, bedding, furniture, tableware, small arms, etc., but will not include consumable supplies, such as coal, food, medicines, etc.

4. The term "outfit and equipment" will also be held to include, not only the original outfitting and equipping, but also renewals and replacements.

5. Materials will be defined as including merchandise suitable for use in the construction or repair of a vessel or its machinery to be incorporated therein after having undergone a process of manufacture subsequent to importation, or in its condition as imported, provided it has been purchased in the open market and was not constructed or fabricated on a special order or after a special design. This will include raw materials, such as pig-iron and lumber, rough forgings and castings, but not finished ones, nuts, screws, bolts, steel plates, ships'-knees, floorings, etc., and other things which, though completed articles, are useful as parts in the construction or something else.

6. The word "articles" is defined as including only such articles as are suitable for use in their condition as imported in the outfit and equipment of a vessel; but such articles may be fitted, polished, painted, or otherwise improved in condition, or fixed in place subsequently.

7. Shipbuilding materials may be entered for warehouse and withdrawn, as desired, within three years from date of importation free of duty upon compliance with the regulations.

8. The regulations provide that materials may be made or manufactured in a custom district other than in which entry is made, and provisions are also made for the disposition of unused portions of importations.

9. Merchandise entered under this act is required to be appraised and classified, but the liquidation of the entry will be suspended pending the production of evidence of compliance with the regulations.

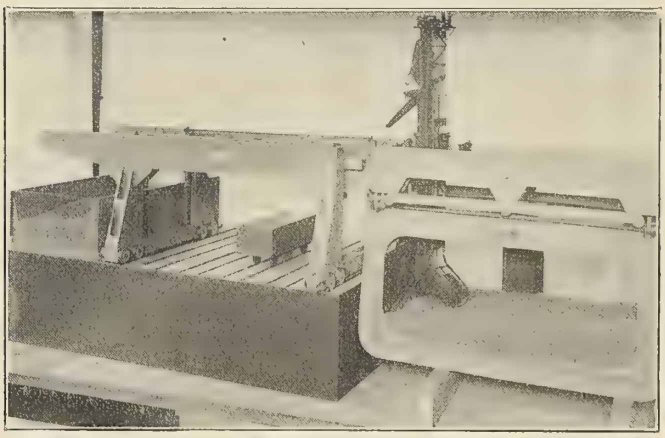
10. Various forms of applications, bonds and affidavits, to show the disposition made of the merchandise, are provided.

11. The regulations further provide that, subject to compliance with the regulations, liquidated entries of merchandise imported on or after August 24, 1912, may be reliquidated free of duty where the liquidation has not become final, and that free entry will be granted to merchandise entered in bond on or after that date for which no permit of delivery has been issued.

Improved Engineering Specialties for the Marine Field

A New Vessel Unloading Machine

The transportation of iron ore and coal on the ocean has been a serious problem, owing to the meager facilities for unloading and the impracticability of installing machinery for unloading vessels similar to that on the Great Lakes on account of the immense investment for special docks and equipment which could be used only intermittently. To overcome this difficulty, ocean-going vessels have been built with false bottoms which are raised on the sides by hydraulic machinery for the purpose of running the load to the center of the ship, from which it is carried out by conveyors; some with bins on the inner side of the hull with a crane for each bin, and many others of different types, all being expensive in first cost, operation and maintenance, although they are an improvement over the old methods which still obtain in some



parts of the world. The latest colliers in the navies of the several powers still leave very much room for economy in cost and in the rate of delivery in bunkering.

To cope with the problem of unloading vessels a new machine devised by Mr. F. H. Kindl has been placed on the market by the Kindl Vessel Unloading Company of Pittsburg, Pa. The general character of the machine can be understood from the view of a model shown herewith. It has a loose scoop bucket, working in an elevator shaft, and may be placed on a crane girder and carried by a vessel, or it may be transferred to a bridge on a dock in a very few minutes. The bucket is watertight, so grain or liquids could be discharged in a pinch, although it would not be so economical for these purposes as a pneumatic machine or a pump. The bucket being removable, a platform could be substituted for hoisting miscellaneous cargo within certain limitations. This feature also facilitates repairs, as the bucket is the only part of the machine which has any considerable wear.

The machine has a wide range of adaptability, as it will handle ore, coal, coke, limestone, gravel, sand, etc., and can be used for ditching and similar purposes. Its capacity can be made to suit many different requirements. The filling of the bucket being a shoveling action under the complete control of the operator, it is necessarily less degrading to such material as coal than the well-known action of the grab bucket. It is claimed to be the only machine which will discharge to cars or a stock pile and successfully transfer the material from stock to cars or vessels without auxiliary hoisting devices.

The weight of the machine and crane girder as designed to be carried by a vessel is approximately 50 tons, which is a very small dead weight when compared with the weight of steel for bins and cranes on the European ore and fuel vessels and the special construction and machinery for the recent colliers in this country.

The Kindl machine can be built with a discharging capacity of 500 tons of coal per hour, and a floating coal storage could be equipped with four machines to bunker coal in two steamers in calm weather simultaneously, two machines working on each ship. The loose bucket weighing approximately two tons, making about four trips per minute, and each machine requiring not more than two men, the cost of operation is infinitesimal when compared with other devices.

Fire Underwriters Make Interesting Test of J-M Pure Cork Sheets

J-M pure cork sheets, manufactured by the H. W. Johns-Manville Company, New York, as shown in the accompanying illustration, were recently tested by the Underwriters' Laboratories, under the direction of the National Board of Fire Underwriters, Chicago, to discover the resistance of the material to destruction by fire under conditions fully as severe as could possibly be expected in actual service. For this purpose a section of 3-inch hard-baked hollow tile wall was built in a steel frame prepared for this purpose, about 10 feet high by 8 feet wide. On this tile there were erected in Portland cement mortar, with joints broken, two courses of J-M pure cork sheets, each 2 inches thick and finished with ½-inch Portland cement, troweled smooth. The panel was twelve days old at the time the test was made. The method of testing consisted of exposing the panel to the attack of a soft, rolling gas flame for one hour with temperatures rising to 2000 degrees F. The furnace was controlled so that the temperatures rose uniformly throughout the test, the maximum temperature being reached at the 60-minute period. At the starting of the test the temperature of the wall section or panel was about 62 degrees F., and at its close the thermometers imbedded in the cork registered an average of 72½ degrees F., while those at the inner edge of the surface of the tile wall averaged about 3 degrees F. lower. It was impossible to tell by the touch at the close of the test on the back of the

tile wall that there was any excess heat on the other side of it, and yet the gas flames had been directed upon the other side for an hour. Directly following the fire treatment, and while the surface of the panel was still in a highly heated condition, a stream of water was applied to the heated surface. It was applied for five minutes through a ⅞-inch nozzle, set 20 feet from the panel, and at a pressure of 60 pounds per square inch measured at the base of the nozzle. The result of the exposure to the gas flames for an hour, followed by the application of the hose stream for five minutes, was to calcine and destroy the outer coating of plaster, and to carbonize and partially destroy the outer layer of 2-inch cork sheets, but the transmission of heat through the carbonized cork layer had

been so slow that the cement coating between the two courses of cork was practically uninjured, the under course of cork remaining intact. The tile wall was in perfect condition, and consequently it was concluded that the properties of the insulating material and its method of construction warrant its approval for use in the insulation of refrigerated structures.

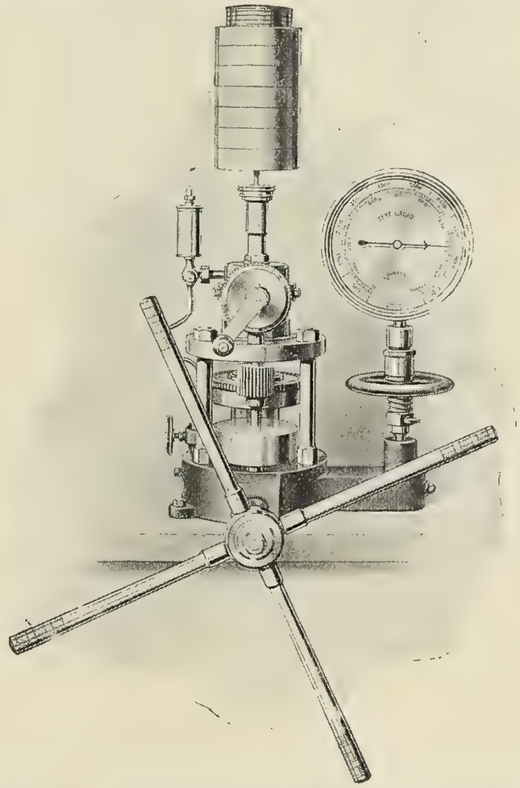
Dallett Pneumatic Wood Carving Tools

Thomas H. Dallett Company, Philadelphia, Pa., has placed on the market a pneumatic wood-carving tool which is useful for any branch of woodworking industry where gouging,

roughing or carving is done, as, for instance, in pattern making. The use of the pneumatic tool is claimed to accomplish the work more quickly and more satisfactorily than by hand. The tool is made in two sizes—a ¾-inch for finishing work and fine carving, and 1-inch, or "Fingergrip," for gouging and heavy roughing work. Each size can be regulated to give the lightest or hardest blow of the piston, according to the operator's wishes, either by placing the thumb over the exhaust hole or cutting down the air supply by means of the stop cock in the hose. Both tools are of the valveless type, the piston is the only moving part, and strikes as many as 2,000 and 3,000 blows per minute according to the pressure carried. A bushing, inserted in the lower end of the barrel, is made for the reception of a shank quarter octagon in shape instead of round, so that the chisel can be held steadily or twisted as desired. The air consumption of the ¾-inch tool is approximately 4 cubic feet of free air per minute and that of the 1-inch "Fingergrip" about 5 cubic feet, the air pressure commonly used being between 70 and 90 pounds per square inch.

The American Multipar Hydraulic Deadweight Tester

The American Steam Gauge & Valve Manufacturing Company, Boston, Mass., has placed on the market a hydraulic deadweight tester where each 10-ounce weight will positively calibrate from 1 pound to 100 pounds pressure per square inch, and a 6¼-pound weight will as accurately calibrate from 100 to 1,000 pounds pressure per square inch. Multiples of these deadweights make its usefulness practically unlimited, it being as simple to calibrate a 25,000-pound gage as one of 5 pounds. This extraordinary range is secured by means of a very simple system of multiple pistons, all of which are fixed and permanent, the third, or top cylinder, having two interchangeable pistons, the larger being used for pressures from 1 to 100 pounds per square inch, the smaller for from 10 pounds to whatever pressure is desired, the outfit as regularly supplied being equipped up to 25,000 pounds per square inch. In operating, a pressure is created by applying weights to the piston in the upper cylinder. This gives a pressure which acts precisely as would weights if applied to the end of the lower piston. It is by means of this upper cylinder that

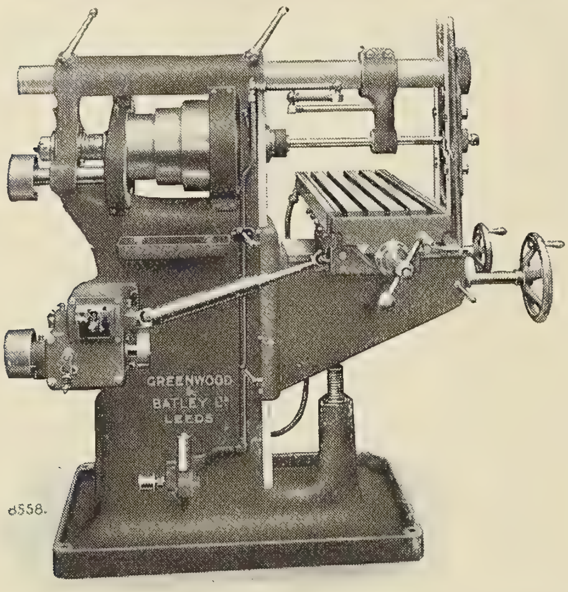


the heretofore insurmountable difficulty of securing great pressure by the use of light weights has been overcome. Low-pressure tests are made by opening a by-pass connecting the upper and lower cylinders, which allows the pressure created by the pressure screw in the lower chamber to connect directly both with the upper chamber and with the gage being tested. The system is thus converted into the original direct deadweight tester.

Horizontal Milling Machine

Greenwood & Batley, Ltd., Leeds., exhibited at the Olympia Engineering and Machinery Exhibition, 1912, a horizontal milling machine which has been completely redesigned, and is now equipped with the most modern and essential features of a high-grade heavy-duty milling machine, specially adapted for general manufacturing work. This machine has a longitudinal automatic feed of 28 inches, a cross adjustment of 11 inches, and a vertical adjustment of 20 inches. It is built both with and without reversing gear to the automatic feed, and is equipped with feed change gear box, solid top knee, arm brace, graduated index disks to all movements, back gears and a two-speed countershaft. A special feature of the design is the absence of complicated mechanism which, while increasing the cost of the machine, has no practical value in a machine intended for manufacturing work. The twelve spindle speeds rise in geometrical progression from 18.5 to 650 revolutions per minute. The end thrust of the spindle is taken by hardened ball-thrust bearing, and any necessary compensation for wear can be made by adjusting nuts at the rear of the spindle. The vertical adjustment of the solid top knee is by a telescopic elevating screw, operated by the larger of the two hand-wheels in front of the machine, and a graduated

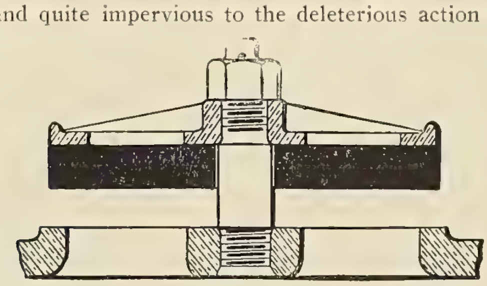
index disk, reading in thousandths of an inch, is fitted to the elevating shaft. The working surface of the table is 44 inches by 14 inches, which is larger than is usual on machines of this capacity. Power feed is provided for the traverse of the table in the longitudinal direction. The automatic speed is driven from the spindle through a change-speed gear box, any one



of eight rates of feed to each speed of the spindle being available by the movement of levers on the front of the feed-gear box.

"Dexine"

"Dexine" is the name and registered trademark of a patent compound of which the owners and sole manufacturers are the Dexine Patent Packing & Rubber Company, Ltd., Abbey Lane, Stratford, London, E. This compound was discovered about sixteen years ago after years of experiment and research, and is, briefly, a composition of vulcanized india rubber and other ingredients manipulated by a special process, the resulting material being of an exceedingly tough and frictionless nature, capable of withstanding extreme temperatures and quite impervious to the deleterious action of acids,



Open.

oils, gases, ammonia and grease. The many uses of this material were shown at the Olympia Engineering and Machinery Exhibition by the manufacturers. Steam users will be interested to know that this material has formed an efficient means of making tight joints for manholes and mud holes in boilers. Since oil fuel has been adopted by many steam users, "Dexine" has also been found useful for the joints of deck plates, tanks and numerous joints required where oil fuel is burned. The material is particularly adapted for use as pump buckets. In this case the plunger is made in two parts, on which the "Dexine" buckets are fitted back to back with an intermediate ring between, serving as an effectual support to the shoulders on the double stroke. "Dexine" is also widely used for conical gage-glass rings, and also for inadhesive packing rings for packing metal rods as well as glass tubes. "Dexine" valves, round, rectangular, disk or flap for air, circulating or straight-lift pumps, are now very largely used, and have proved to be much more valuable than ordinary india rubber. The type of valve for such purposes is shown in the illustration.

A Boiler Scale Remedy

The United States Graphite Company, Saginaw, Mich., have on the market a boiler graphite made from the product of mines in Mexico which is claimed to be a sure and safe boiler scale remedy. Owing to the unequal expansion and contraction of the metal of a boiler, and the scale in it, the latter during alternating periods of heating and cooling becomes more or less cracked, and on account of these small cracks pure graphite, suitably prepared and circulating with the water, finds its way through these minute openings, and deposits itself on the inner surface of the tubes and shell between the metal and the scale, with the result that the latter will no longer adhere tenaciously and may be removed with comparative ease. Continued use of this graphite after the boilers have once been cleaned prevents the subsequent accumulation of hard scale. The use of this remedy has the advantage that it does its work without doing any harm to the boiler itself, since its action is mechanical instead of chemical.

Obituary

Lord Christopher Furness, First Baron of Grantley and the head of the Furness Steamship Line and of Furness, Withy & Company, died Nov. 10 in London. Lord Furness was born in West Hartlepool, April 23, 1852. From 1891 to 1895, and again from 1900 to 1910, he was a Liberal member of Parliament from Hartlepool. Among the enterprises in which Lord Furness was heavily interested was the Cargo Fleet Iron Company. In 1897 he effected a consolidation of the British Maritime Trust and the Chesapeake & Ohio Steamship Company, of which lines he was president.

Clement A. Griscom, one of the founders and the first president of the Society of Naval Architects and Marine Engineers, and an honorary member of the Institution of Naval Architects, died suddenly at his home in Haverford, Pa., Nov. 10. Mr. Griscom was born in Philadelphia, March 15, 1841, and received his education at the Friends' Central High School. At sixteen he was graduated and obtained a clerkship in the old, conservative shipping house of Peter Wright & Son, of which he became a partner as soon as he attained his majority. Mr. Griscom began the operation of the old American Line in 1871 with the only steamers then flying the American flag in the North Atlantic. From this beginning he brought together under one management the greatest steamship combination in the world, which reaches all the principal ports of the North Atlantic. Mr. Griscom was successively vice-president and president of the International Navigation Company, which he organized, and in 1892, with the co-operation of J. Pierpont Morgan, he merged it into the International Mercantile Marine Company, of which he was president until 1904 and chairman of the board of directors until three years ago.

Clement Mackrow, manager of the shipbuilding department and naval architect of the Thames Iron Works & Shipbuilding Company, Ltd., was accidentally killed Sept. 23. Mr. Mackrow's entire business career was spent in the Thames Iron Works Company, where, entering the business at an early age, he followed in the footsteps of his father, being employed first in the drawing office and then passing successively through the various other departments of the works, devoting his entire career to the construction of first-class ships. Mr. Mackrow was a member of the Institution of Naval Architects, and was lecturer on naval architecture at the Bow and Bromley Institute. He has long been well known in the marine field as the

author of "Naval Architect's, Shipbuilder's and Marine Engineer's Pocketbook."

Samuel A. Cramp, a son of William Cramp, founder of the Cramp Ship & Engine Building Company, died, Nov. 3, at his home in Philadelphia, aged 79 years. At the time the Cramp interests were sold to the present owners in 1896, Mr. Cramp was president of the Company. He had begun his career, like his brothers, as an apprentice, and had worked his way up step by step into an executive position.

Gustav H. Schwab, head of the firm of Oelrichs & Company, general agents for the North German Lloyd Steamship Company, died at Litchfield, Conn., Nov. 12. Mr. Schwab was born in New York in 1851. He received his early education from a private tutor, and in his fourteenth year he was sent to the Gymnasium at Stuttgart, Germany. He entered the mercantile profession in his eighteenth year in Bremen in the employ of H. H. Meier & Company. In 1873 he returned to New York, and entered the office of his father's firm, Oelrichs & Company, and took charge of the agency of the North German Lloyd. On July 1, 1876, he became a member of the firm of Oelrichs & Company, and continued in the active management of the firm's affairs until his death. Mr. Schwab was closely associated with a great number of important financial institutions and had an important part in many public affairs.

Technical Publication

Fighting Ships. Fifteenth Edition. Edited by Fred. T. Jane. Size, 12½ by 7½ inches. Pages, 546. Numerous illustrations. London, E. C., 1912: Sampson Low, Marston & Company, Ltd. Price, 21/– net.

The principal innovation of this year's "Fighting Ships," as stated in the preface, is that owing to the courtesy of the various Admiralties concerned the proofs of most of the ship pages have been officially revised. This has led to the non-publication of certain more or less speculative plans of new ships, building or projected, which can be considered only as "intelligent anticipations" rather than accurate data. As is usual, photographs of new ships have been obtained where possible, and the system of replacing those of old ships by modern photographs wherever any small change in the appearance of the ship has been made has been adhered to.

As is well known, the main particulars of all of the naval vessels of practically every naval power in the world are tabulated in this book, each navy being taken up in the order of its strength. The information is presented as briefly as possible in tabular form, a separate page being devoted to each of the vessels, or class of vessels when there are several built according to the same design, together with photographs of the ships, and drawings showing the disposition of armor and armament. The dates of laying down and completion, with data from the trials, are given in each case, together with general notes summing up the special features of the vessel or vessels described. The order of the great naval powers in the present volume is: First, British; second, German; third, United States; fourth, Japanese; fifth, French; sixth, Italian; seventh, Austro-Hungaria, and eighth, Russian.

The second part of the book contains two interesting articles, the first by Mr. C. de Grave Sells, on the "Progress of Warship Engineering," and the second by General Cuniberti, chief constructor of the Italian navy, on the "Battleship of the Future."

The first article is practically a review of the information which has been published during the past year in the engineering press regarding the development of naval engineering. As the present year is the one hundredth anniversary of the commencement of British steam navigation, the details of the *Comet,* the first commercial steamboat operated in Great Britain, are contrasted with the features of the latest British warships such as the *Lion,* showing the wonderful development which has taken place in shipbuilding in the first century of steam navigation. In discussing the present tendencies of propulsive machinery for war vessels the relative advantages or disadvantages of turbine and reciprocating-engine drive are compared by describing the trials of the two Italian battleships *San Giorgio* and *San Marco,* two sister ships, the former having reciprocating engines and the latter turbine machinery. The results of these trials, the author states, are considered to demonstrate the unquestioned superiority of the turbine over the reciprocating vessel in this class of vessel. He then gives data obtained from the trials of several United States destroyers which were equipped with different types of turbines. Following this is a description of the results obtained with different types of reduction gear, including mechanical, hydraulic and electrical transmission. Other subjects considered are the erosion of high-speed screw propellers, the corrosion of condenser tubes, superheating, and the recent developments in auxiliary machinery and machine tools.

The last part of this article is devoted entirely to the question of motor ships and internal-combustion engines. No attempt is made to describe in detail all of the different types of Diesel engines which have been adapted to marine work, but the principal installations which have been made during the past year are described and the advantages of this type of propulsion are discussed. Although he emphasizes the fact that there are serious disadvantages to be overcome in the use of internal-combustion engines for large ships he does not enumerate the disadvantages as fully as might be expected. In conclusion, he states that it is certain that another line of progress will be a further substitution of oil for coal, either for the generation of steam or for the direct use in the cylinders, although to what extent will largely depend upon the amount of production of the oil fields and the action of those who control the supply.

The second article in Part II. is of special interest, both because of the high esteem in which the author, General Cuniberti, is held in the naval world, and because of the importance of the subject. The present tendencies of battleship design point out that the future ship will be of the "all-big-gun" class. What is looked for in the development of the gun is that a desirable weapon shall be developed to be capable of long service and of always retaining its original precision of fire, the arrangement of the armament probably being worked out, as was first done in the United States navy, by placing all of the guns on the center line of the ship with the turrets on different levels, the exact position of the guns, of course, further depending upon the grouping of boilers and funnels and the installation of the magazines. Another development which must be looked for in connection with the improvement of the range and accuracy of torpedoes, is more adequate under-water defense of the battleship against torpedo attack. The tendency in the matter of armor indicates that the extensive but deficient protection of to-day is about to undergo a serious evolution, making way for a less extensive but much heavier armor—possibly 16 inches thick—capable of providing ample protection to the vital parts of the ship. The increase of armor, however, is directly opposed to the present tendency of increasing speed, since an increase of speed, if the heavier armor is retained, means a larger displacement, and therefore a greater area to be protected. Apparently, General Cuniberti believes that the tendency to sacrifice armor protection for speed is a step in the wrong direction, as in that case only the waterline and gun stations are partially protected, whereas what is required is an actual citadel absolutely secure and impenetrable from the large shell of the future, and which after many hours of combat may still be intact and render its full efficiency, thoroughly protecting all vital functions of the vessel and particularly maintaining the reserve buoyancy and reserve forces.

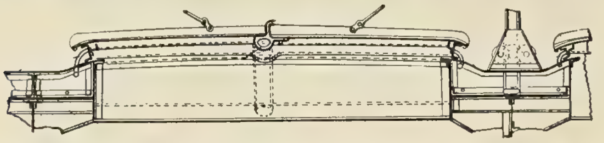
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,028,263. SHIP'S HATCHES AND DECKS. JOSEPH R. OLDHAM, OF CLEVELAND, OHIO.

Claim 3.—In ship construction, the combination of a pair, or pairs, of metal hatches with inner-adjoining-margins upwardly flanged, one flange of each pair of hatches having a slight projection adapted to cover the joint of said upwardly turned margins, the fellow hatch margin being constructed with a gutter below said flanges adapted to receive any leakage between said margins and to convey the water into drain pipes



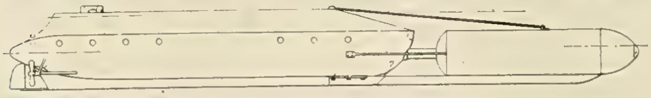
leading from around super-coamings, into wing ballast tanks or deck chambers between hatchways; outer margins of hatches downwardly curved and adapted to be seated on outwardly inclined or beveled super-coamings, said hatches being fitted with hinges attached to a platform deck to facilitate the raising and lowering of hatches when actuated by tackles. Eleven claims.

1,028,387. SUCTION DREDGER. ERASTUS E. ROBERSON, OF LE GRAND, CAL., ASSIGNOR OF TWO-THIRDS TO WILLIAM A. HUELSDONK, OF LE GRAND, CAL.

Claim 1.—A dredger comprising two floats spaced apart, a conveyor pivotally mounted between said floats, a frame hinged to each of said floats and spaced apart, an independent auxiliary float on the outer end of each of said frames, and means connecting said conveyor to said frames. Three claims.

1,028,473. TORPEDO BOAT. HUDSON MAXIM, OF HOPATCONG BOROUGH, N. J.

Claim 1.—In a torpedo boat, the combination of the hull of the boat, a dispensable bow portion or compartment, an explosive charge in the



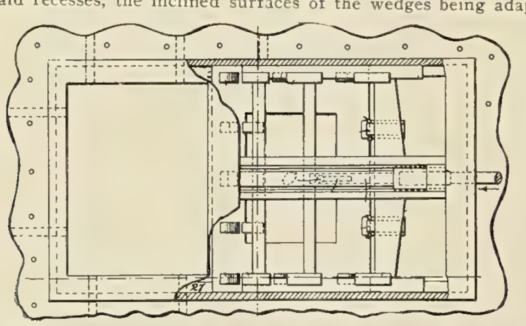
forward end thereof, and a tamping material in said bow portion between said explosive charge and the bow of the torpedo boat proper. Fifteen claims.

1,028,897. MARINE CABLEWAY. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

Claim 1.—In a cableway, the combination with a drum, of a fluid pressure operated engine therefor, a cable under tension actuated by said drum, and means automatically acting in accordance with the degree of tension of the cable for increasing the fluid pressure of the engine when the tension on the cable is reduced and for decreasing such fluid pressure when the tension on the cable increases. Thirty-nine claims.

1,029,620. DOOR, HATCH, OR LIKE CLOSING DEVICE. GIUSEPPE MAZZOLINI, OF NAPLES, ITALY.

Claim 3.—In a combination, a door frame, a sliding door associated therewith and provided with recesses having inclined surfaces, a frame movably connected to said door and provided with wedges adapted to enter said recesses, the inclined surfaces of the wedges being adapted to



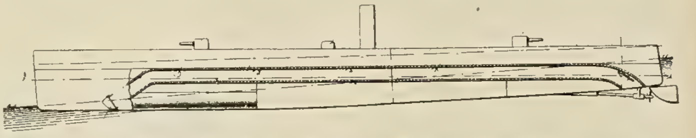
engage the inclined surfaces of the recesses, means for moving said frame to move said door into registry with the door frame and means for arresting the movement of the door, whereby movement of said frame relatively to said door, will cause the inclined surfaces of the wedges to slide along the inclined surfaces of the recesses, thereby forcing the door to move in a direction substantially at right angles to its first direction of movement. Four claims.

1,029,546. CONSTRUCTION OF FLOATING VESSELS. JOSEPH WILLIAM ISHERWOOD, OF MIDDLESBROUGH, ENGLAND.

Claim 1.—A vessel in its main body portion provided with consecutive transverse frames individually a plurality of times stronger and spaced a plurality of times farther apart than has heretofore been customary in the same class of vessel, said frames extending to the shell or deck plating of the vessel, said vessel being also provided in said portion thereof with longitudinal frames which, as compared with the transverse frames are individually weak and very closely spaced, and which also extend to the shell or deck plating of the vessel. Twelve claims.

1,028,472. WAR VESSEL. HUDSON MAXIM, OF NEW YORK, N. Y.

Claim 2.—A war vessel having water compartments for its immersion,



with downwardly and forwardly inclined inlet passages, and rearwardly and downwardly inclined outward passages, and valves controlling said passages. Ten claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

18,789. RAISING AND LOWERING GEAR FOR SHIPS' BOATS. A. J. BILLS, STRATFORD.

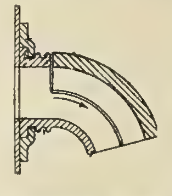
According to this invention, the boat fits in chocks which slide outboard for launching. The davits also are movable in and outboard and are connected to the boat by means of a gunwale-gripping-rod carried by a bar joining them together. When these davits are pushed outboard this rod also pushes out the boat and chocks. The latter are in halves, hinged together beneath the keel of the boat, so that the outer half can drop clear of the boat over the side to allow he boat to swing clear. The davit carriages and chocks are normally prevented from moving by means of pawls and racks and also by readily disengaged links by which the cross-bar is secured to the deck.

16,443. WARMING OR COOLING AND VENTILATION OF STEAMSHIPS AND THE LIKE. D. M. NESBIT, LEICESTER.

This invention has for object a system of warming, cooling and ventilation in which every advantage of the natural elements and speed of the vessel is taken. To this end the fresh air for warming or ventilating is admitted upon the forward side of the funnel casings while the foul air escapes or is forced out on the after side of them. Arrows on the drawings show the air entering to supply blowers which force it into side ducts, whence it supplies the various rooms, etc., returning after use to the rear of the funnel, and issuing at the head of duct. Switches are for controlling the fans. Coils may be provided for heating the air.

22,222. ASH EJECTORS. F. J. TREWENT AND W. E. PROCTOR.

The invention relates to a nozzle for ash-ejectors, curved so as to discharge the mixture of ashes and water in a direction parallel to the ship's side and downward so that the issuing refuse may be kept from



the influence of strong head or beam winds. That part of the nozzle which alters the direction of the issuing stream, and which is consequently most worn by it, is made readily detachable and renewable. Several ways of carrying the invention into effect are described. In one variation the nozzle is rotatable.

7,963. SELF-REGISTERING COMPASSES. A. B. C. THOMSEN, COPENHAGEN.

By this invention the movements of the compass card are recorded by a beam of light transmitted through a lens in the card or reflected from a mirror carried upon it. An electric lamp sends rays to a conical mirror which directs them through the converging lens in the card to a second conical mirror by which they are turned to the recording cylinder. This has no movement of rotation, but falls axially, regulated by an escapement. Then, if the course is held, the record is a straight line. When tacking, the record is a zigzag line, and when turning quite round it is a helix.

15,674. MARINE BOILER AND OTHER FURNACES. R. CAMPBELL, LIVERPOOL.

The rocking fire-bars are provided with auxiliary bars at their rear ends, and hooked upon a supporting bridge in such manner that they provide an air channel and so that they are shaken up and down at the same time as the main bars. Extensions passing between the latter ensure that the auxiliary bars move downwards. The bridge is adjustable for varying the grate area. This arrangement prevents the congestion of dead fuel at the bridge while ensuring better combustion and increased efficiency.

2,812. SEA-WATER EVAPORATORS. W. WEIR, GLASGOW.

This evaporator is of the type in which the heating coils are arranged one above the other and have their two ends connected respectively to steam chamber and exhaust, both in the lower part of the shell. By this invention the chambers are located on the side of the shell opposite the door through which the coils are inserted and withdrawn, and the coils are connected to the chambers by couplings whose axes are parallel to the line of withdrawal of the coils through the door, so that every coil can be disconnected and withdrawn, by a single straight line movement, and can be of a size sufficient to practically fill the horizontal section of the coil containing portion of the shell, which may then be made to occupy the minimum space.

TRADE PUBLICATIONS.

AMERICA

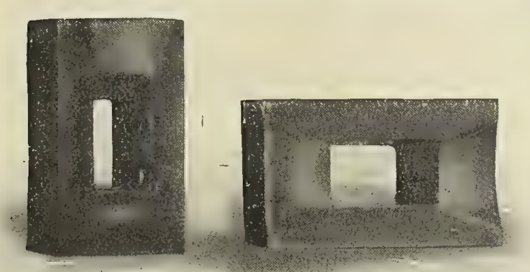
Smooth-On Iron Cement Book No. 7 has just been issued by the Smooth-On Manufacturing Company, Jersey City, N. J. Smooth-On Iron Cement No. 7 is a hydraulic, chemical iron cement, prepared and sold in powdered form and used for waterproofing, stopping leaks of concrete, hardening concrete and for bonding concrete to concrete and brick to brick on any porous substances. The new instruction book is illustrated; the illustrations show a few of the many ways in which this Smooth-On Iron Cement No. 7 has been used and the results obtained. It will prove valuable and interesting reading to anyone troubled with concrete leaks or the hardening of concrete. A copy of this book will be sent free of charge to anyone sending their name and address to the Smooth-On Manufacturing Company, Jersey City, N. J.

A free copy of the 1912 edition of the "Red Book," published by Toch Bros., 320 Fifth avenue, New York, will be sent to any of our readers upon request. This booklet should be in the hands of every person interested in the subject of marine paints and damp-proof coatings of any nature. In this connection it may be stated that the steel hull of the U. S. battleship *New York,* which was launched Oct. 30 at the Brooklyn navy yard, was painted below the waterline with a foundation priming anti-corrosive coating of "Tockolith," a patented cement paint. This composition is also valuable for waterproofing between the decks of boats and for paying seams. It is applied cold, which is a great advantage over other materials. The manufacturer states that it has been used in thousands of places and always with positive damp-proof results. Toch Bros. have been inventors and manufacturers of painting materials for sixty-four years, and after years of practical construction tests have been successful in having their "Tockolith" priming paint adopted for some of the greatest steel structures ever erected. On pages 31 to 41 of the "Red Book" is a technical description of this company's paints. Every shipbuilder, ship owner, superintendent, naval architect and marine engineer should ask for a copy of the "Red Book."

Ventilation and draft fans are described in a catalogue issued by the B. F. Sturtevant Company, Hyde Park, Boston, Mass. In this catalogue the statement is made that on the United States battleship *Wyoming* are installed 40 Sturtevant hull ventilation fans, 12 Sturtevant forced-draft fans, and 12 Sturtevant portable ventilating fans—a total of 64 Sturtevant fans with an aggregate capacity of 565,600 cubic feet per minute. The *Arkansas,* a sister ship, has a similar equipment. The Sturtevant Company is prepared to meet all requirements for fans and electrical apparatus for marine use.

The November issue of the *Nlesco News,* published by the New London Ship & Engine Company, Groton, Conn., is a fuel oil number. "The rapidly increasing demand for suitable fuel oil, made necessary by the success of the heavy oil engine, has led to considerable speculation as to the supply and availability of the work. In this issue of the *Nlesco News* we devote our first page to a discussion on fuel oil, and hope that it will be of interest not only to our patrons interested in our engine, but also to those who have any connection with the production and sale of oils." A free copy of this pamphlet will be sent to any reader of INTERNATIONAL MARINE ENGINEERING upon application.

Steam gages, indicators and other steam specialties are described in a catalogue published by the American Steam Gauge & Valve Manufacturing Company, 208 Camden street, Boston, Mass. "A cheap inaccurate gage, for example, may easily waste its cost many times. An inaccurate indicator will, because of improper valve settings based on its diagrams, waste hundreds of dollars in coal consumed and power lost. The cost of any perfectly-made instrument is quickly forgotten in the satisfaction which always accompanies the use of such an instrument. American quality products are manufactured solely because of the above good reasons. Every instrument is built on honor of the best materials, and by the best workmen that can produce these instruments. We have specialized in the manufacture of power measuring and controlling devices for over sixty years. No other manufacturer in the United States knows so well as we how to produce a perfect gage, a perfect indicator or a perfect safety valve, either for stationary, locomotive or marine use. You are saving nothing by buying cheaper products, and you are insuring yourself, your plant and your service when you equip with American quality products."



"Vulcan" safety dogs and other drop-forgings are described by J. H. Williams & Company, 63 Richard street, Brooklyn, N. Y., in a catalogue this company has just issued. These dogs, according to the catalogue, offer safety in simple form, a better balance in the lathe, tempered headless screws and toughened dog wrenches. "The price is the same as for dangerous and otherwise less desirable forms of tools."

Oil Burning Without Steam or Air.—The Körting mechanical system, made by the Schutte & Körting Company, Philadelphia, Pa., atomizes oil by mechanical means, *i. e.,* without steam or air, as the atomizing medium. The system operates smokelessly and noiselessly, and installations in various types of vessels, stationary plants, etc., total over 150,000 horsepower. This system is described in Bulletin 6-0, a copy of which will be sent to any of our readers upon request.

The Auld reducing valve is described in Catalogue 8-R issued by the Auld Company, 1255 North Twelfth street, Philadelphia, Pa. "This well-known reducing valve, made for so many years by the Auld Company, Glasgow, Scotland, is now made in the United States by the Schutte & Körting Company. We have already sold a large number of these valves and they are giving absolute satisfaction. The valve is extremely accurate, and having no sleeves or shifting boxes there is no friction, therefore no irregular working. Constant reduced pressure is maintained even with great fluctuations in initial pressure."

"Graphite in Boilers" is the title of the leading article in the November issue of *Graphite,* published by the Joseph Dixon Crucible Company, Jersey City, N. J. After reproducing an interesting article on this subject, which was recently published in *Power,* the Joseph Dixon Crucible Company goes on to state: "The action of graphite in boilers is purely a mechanical one, and so the grade used must be one that will not have a tendency to pack and collect in one place, but rather one which will spread out evenly over the whole boiler surface. Dixon Ticonderoga flake graphite is well known for its ability to stay placed upon metal surfaces, and has been found best adapted for boiler requirements." Detailed information as to use, etc., will gladly be furnished upon request.

"Prompt vs. Dilatory Freight and Merchandise Handling" is the subject of a catalogue issued by the Otis Elevator Company, Eleventh avenue and Twenty-sixth street, New York. All who are interested in the problem of economically handling large volumes of freight or merchandise in transit, or in steamship piers and storage warehouses, should send for a free copy of this catalogue. "In construction the Otis inclined elevator is extremely simple and can be comprehended by a study of the illustrations in this book. It consists, primarily, of an endless steel chain or platform revolving about sprockets at either end which are driven by a conveniently located motor. The elevator can be started, stopped, or reversed at any point during its travel. In operating, the truckman brings his loaded truck to the elevator; the flange or lug of the elevator engages with the truck, and the man, truck and load are transported from level to level, quickly, safely and without physical effort. The operator may, or may not, as so desired, accompany the load on its transfer from floor to floor. No matter what kind of truck is used, how much the loads may weigh, or how fast they come, the Otis inclined elevator will move them promptly and surely. From the initiation of the load until its delivery at destination it remains intact. It is particularly adapted to the varied merchandise of department stores; parcels in express offices and railroad stations; freight to and from vessels and docks; freight at railroad terminals; bags, bales, boxes and packages in stores and warehouses; transfer or finished parts, or merchandise in process of manufacture in mills and factories. On the following pages are illustrated the many types of inclined elevators which we manufacture, showing complete installations and typical layouts of the apparatus. In order to estimate the cost of Otis inclined elevators it is necessary for us to know the distance from floor to floor, or rise, location and size of beams; also floor construction, whether wood, concrete, or other material and depth of same. To help you prepare this information we refer you to the typical layouts of each type of inclined elevator. When writing for information please make reference to the typical layout sheet number, and without obligating you in any way we will prepare specifications and estimates of any machine to meet your specific requirements. If you own or manage or are planning to build a store, factory, freight terminal or building, where merchandise should have constant movement, or have old buildings you want modernized to produce large income, we invite you to make a thorough investigation of the Otis inclined elevator. Any of our offices will be pleased to have your inquiries."

Gasoline electric generating sets are the subject of Catalogue 205 just published by the B. F. Sturtevant Company, Hyde Park, Mass. "Sturtevant gasoline generating sets consist of Sturtevant gasoline engines direct connected to Sturtevant direct-current electric generators. The engine is of the four-cycle, water-cooled vertical type, with either four or six cylinders, according to the size of the unit. These sets are built in three sizes—5, 10 and 15 kilowatts capacity, capable of lighting 200, 400 or 600 twenty-candlepower tungsten lamps. A long-stroke engine has been designed as the most efficient and practical for this service. Both engine and generator are capable of operating under an overload of 25 percent for two hours."

The Penberthy Injector Company, Detroit, Mich, is sending out an 80-page book, and every superintendent and engineer at all interested in engine and boiler room practice should have a copy. It is complete with illustrations of injectors, ejectors, regrinding valves, safeguard water-gages, etc. "It thoroughly describes them, gives many facts to be considered in the selecting and handling of injectors, methods of connecting, information regarding repairs, tables of capacities, and really gives a great deal of information that will come in handy to any engineer, and the Penberthy Injector Company offers to send it free of charge to those who care to write for it, mentioning International Marine Engineering."

The Watertown automatic safety water gage is described in a folder published by the Watertown Specialty Company, Watertown, N. Y. "We bring the Watertown automatic safety water gage to your attention secure in the knowledge that there is no other possessing all the qualities of automatic safety action; automatic release of valve when glass is replaced; replacement of glass without shutting off valves by hand; impossibility of false water level; accessibility to all passageways for cleaning without removing from boiler; automatic cleaning of safety check valves when the glass is blown down; top and bottom valves interchangeable; automatic action when closing and opening when glass breaks or is replaced. All requirements of the Inter-State Commerce Commission are met with."

In a 120-page book, entitled "De Laval Steam Turbines, Multi-Stage Type," the De Laval Steam Turbine Company, Trenton, N. J., has presented much more than an ordinary trade catalogue. A third or more of this publication is devoted to a discussion of the "speed compromise" problem; that is, of finding the best means of reconciling the high speed natural to steam turbines with the low or moderate speeds of driven machinery. The relative advantages of the several fundamental types of turbines, as affecting this and other matters, are discussed under the following chapter heads: "The Field of the Single-Stage Turbine"; "The Necessity for Multi-Stage Construction for Large Turbines"; "Advantages of Speed Reduction by Gears"; "Considerations Affecting Choice of Type of Turbines"; "Relation Between Rotative Speed and Number of Stages"; "Effects of Different Methods of Compounding"; "Choice of Type of Turbine"; "Benefit of the Driven Machine from Being Able to Obtain the Proper Speed"; "Alternator Speeds"; "Direct-Current Generator Speeds"; "Centrifugal Pump Speeds"; "Fan and Blower Speeds"; "Speeds for Rope and Belt Drives." The remainder of the book is occupied by a detailed description of the design and construction of the De Laval multi-stage or multi-cellular turbine, which is built in capacities of 500 horsepower and up, and of the De Laval speed reducing gear, by means of which this turbine is applied to driving standard speed, direct-current generators, centrifugal pumps and blowers, and for rope and belt drive. "A novel feature in the construction of the De Laval multi-cellular turbine is the use of solid steel rings, which are shrunk over the stationary guide vanes of the diaphragms, entirely encircling the wheels. These rings provide an impenetrable steel armor, which will effectually prevent injury to surrounding objects or persons in case the turbine should be over-speeded, as through lodgment of objects under the governor valve. A chapter at the end of the book is devoted to showing that because of their lower first cost, steam turbine-driven centrifugal pumps can compete successfully with the most efficient triple-expansion pumping engines wherever coal does not cost more than $6.00 to $8.00 per ton. The book also contains a chart accompanied by a "steam scale," by means of which the energy available from the expansion of steam between given limits can be read off directly as heat units, velocity of the steam in feet per second, duty in foot pounds per thousand pounds of steam, and pounds of steam consumed per horsepower-hour. Copies of this book will be sent upon request to those concerned in the management or operation of steam plants."

Reducing valves are the subject of Bulletin No. 4, published by the Lytton Manufacturing Corporation, Franklin, Va. "They shut off when consumption stops. Reduced pressure can be changed while in operation."

The velocity stage type of De Laval steam turbines is described in a 48-page booklet recently issued by the De Laval Steam Turbine Company, Trenton, N. J. "This is a velocity stage turbine with a single pressure stage, built in sizes up to 600 horsepower, suitable for direct connection to centrifugal pumps and blowers and small alternating-current and direct-current generators, etc. With the intermediation of gears the turbine may be adapted to drive slow and standard speed machinery, also for use with rope or belt drives. The pamphlet outlines the factors affecting the suitability of different types of turbines for the several services involved; the speed problem, as bearing upon the type of turbine to be selected; methods of velocity staging for small turbines, such as the use of multiple rows of buckets with intervening guide vanes, or returning the steam jets upon the original row of buckets, and practical considerations, such as renewability, governing, non-penetrable casings, shaft design and freedom from vibration, bearings, the strength of wheels, the best form and material of buckets to resist erosion, ease of access to internal parts, economy, facilities for changing the nozzles to meet changes in steam conditions, etc. The turbines here described and illustrated by 31 views and installations embody several distinguishing features, some of which are novel. For instance, all openings are in the bottom part of the casing, so that the cover may be lifted off without disturbing steam or exhaust connections. This exposes all rotating and working parts, which may then be lifted out after removing the bearing caps. All wearing parts, such as nozzles, buckets and guide vanes, are renewable without involving the renewal of other parts. The wheels are surrounded by a solid steel ring, sufficiently heavy to prevent penetration of parts of the wheel in case the latter should be ruptured by over-speeding. Possibility of such accident is guarded against by a duplicate governing device operating an entirely independent valve. This form of turbine is built for all steam conditions, *i. e.*, receiving high-pressure steam and exhausting to condenser or atmosphere or against back pressure, or operating on low-pressure steam, either alone or with mixed flow. Copies of the book will be sent gratis to those interested in steam power plant equipment."

"Sirocco" fans are described in Bulletin 340-ME., published by the American Blower Company, Detroit, Mich. "Sirocco fans deliver more air at less expense for power than the ordinary steel plate fan of twice the size."

"Diamond" soot blower is described in Bulletin 1, published by the Diamond Power Specialty Company, 58 First street, Detroit, Mich. The steamer *Col. James M. Schoonmaker*, the largest steel bulk freighter in the world, is equipped with "Diamond" soot blowers, and the chief engineer of the ship states that these blowers are extremely satisfactory, and that they do all that could be expected of them.

"J-M Permanite Packing" is the subject of a bulletin published by the H. W. Johns-Manville Company, Forty-first street and Madison avenue, New York. "J-M Permanite Sheet Packing No. 60 is adapted for high or low superheated or saturated steam; hot or cold water at any pressure; air, oil, ammonia and various acidulated and alkali solutions. The company will send a square foot of this packing as a sample, free of charge, to all those interested."

Class C turbines are the subject of booklet G46, published by the De Laval Steam Turbine Company, Trenton, N. J. "The shaft is exceptionally large, and each row of buckets is mounted on a separate wheel rather than upon the broad rim of one wheel. There are two governors—one a speed governor and the second an independent emergency governor which trips a safety shut-off valve. In any case damage to wheel case or surroundings is absolutely prevented by the heavy steel retaining ring. A safety relief valve is attached to the casing cover. Made in all sizes suitable for the driving of power plant auxiliaries."

The subject of safety and greater reliability in the navigation of sea-going vessels which travel or dock at night is taken up in bulletins published by the General Electric Company, Schenectady, N. Y. According to the bulletins, safety and reliability in the above-mentioned circumstances are secured by the use of the General Electric Company's searchlights, built especially for marine service. The company is prepared to furnish from stock standard commercial projectors of 9, 13 or 18-inch diameter for either pilot-house or hand control. Larger sizes up to 80-inch diameter and projectors suitable for special requirements of control are furnished to meet every condition of marine work.

"Autogenous Welding" is the subject of circulars distributed by Messer & Company, The Bourse, Philadelphia, Pa. "One of the latest and most important auxiliaries in iron and metal working is supplied by the autogenous welding of metals, chiefly by means of the acetylene oxygen flame, which is equally well adapted for welding wrought and cast iron, steel, copper and other metals, at the same time dispensing with the application of hammering, pressure, solder or any other means of fusion during welding, there being, in fact, a smelting together or conflux of the metals. Instead of using complicated joining methods that require rivets, screws and the like, the work is done efficiently in a far cheaper way. Formerly expensive and time-wasting repairs of ruptures and fissures in machine parts, steam boilers and other receptacles can now be made most expeditiously and at a relatively small cost. Casting faults in iron and metal foundries can be rectified in the most simple and efficient manner. An acetylene oxygen welding plant, notwithstanding its extraordinary advantages, is of surprising simplicity in construction and operation. Hence it will presumably be introduced before long as indispensable in the largest industrial concerns as well as in the smallest workships. The acetylene oxygen welding is by two-thirds cheaper than the autogenous welding of metals by means of hydrogen and oxygen. Moreover, it admits of the welding, for instance, of iron up to a thickness of 2 inches without preliminary heating, whereas this can be done with the other welding methods referred to only up to a thickness of ⅜ inch. Our welding blow pipes are provided with contrivances of the greatest importance (the patent for which has been applied for), and are remarkable for their unexceled economy in gas as well as for their faultless working. They have stood the test of efficiency so extremely well as to be distinguished by the gold medals as the highest awards. We can furnish the highest references. Our apparatus are in operation by the railroads, in the navy, in large industrial concerns as well as in small factories and workshops, and invariably give the greatest satisfaction. We are always prepared to demonstrate to any interested parties the acetylene oxygen welding process in progress in our own works. The welding of all metals can be acquired within a few days free of charge in our own works. Or we send professional welders to teach interested parties outside of our establishments at very moderate charges."

Improved rotary bevel shears are described in an illustrated catalogue just published by the Hilles & Jones Company, Wilmington, Del. The claim is made that these rotary bevel shears combine all the latest improvements in design, and that they are constructed with an excess of strength beyond the rated capacities. "For many classes of work a totary bevel shear is as satisfactory as a plate planer, and the saving in time over edge planing is an important consideration. On curves and irregular shapes it is invaluable compared with hand work."

"The Hunt Automatic Railway" is the title of a 32-page booklet issued by C. W. Hunt Company, West New Brighton, S. I. "The Hunt automatic railway was designed primarily for transporting coal, sand, phosphate rock, ores, limestone, salt, cement and similar bulk materials from railroad cars and vessels to storage bins or pockets where the run does not exceed 600 feet. So many of these railways have now been installed in all parts of the country and are operating under such a wide range of conditions, some continuously during the past forty years, that we can submit any number of performance records to prove that they afford absolutely the most economical and satisfactory means of accomplishing their purpose. The cost of operating this elevated self-acting railway is confined to the expense of one man's wages, for the car, once loaded and started, runs down the track, dumps its load at any desired point, and returns to the starting place entirely under the action of gravity. The workman does not even accompany the car; the operation is so entirely automatic that no attention whatever is required from the time of starting with load until the return empty and ready for the next load. Moreover, the car runs with great rapidity, making a trip of 300 feet, dumping its load and returning in about fifty seconds. Materials received over the automatic railway can be accurately weighed without delay or extra expense by placing platform scales in the track at the loading end; the workman who loads the car also weighs it, and while the car is running down the tracks enters the weight in the tally-book. Almost any area within a radius of 600 feet can be covered by having the required number of automatic railways radiate from a central receiving point, the capacity being limited only by the number of cars in operation. Where there is no time limit one car switched from track to track can be made to cover the entire storage space."

Rotary pumps, feed-water regulators, disk fans for ventilation, positive-pressure blowers and blowers for mechanical draft are described in a folder published by the L. J. Wing Manufacturing Company, 352 West Thirteenth street, New York.

The Wisconsin Carbonic Safety System for refrigeration and ice-making is described in a circular issued by the Wisconsin Ice Machine Company, 322 South Michigan Boulevard, Chicago, Ill., and a statement is made regarding the case of "The Carbonic vs. the Ammonia Machine."

The Star "non-corrosive" steam gage is described in an illustrated circular published by the Star Brass Manufacturing Company, 108 East Dedham street, Boston, Mass. This circular states that the Star gage is the only one made with a movement that won't rust. "Both the non-corrosive and corrugated tube features are patented and found only in our make."

Marine engines are described in a catalogue just issued by the Wolverine Motor Works, Bridgeport, Conn. This company makes both oil and gas engines, and makes a specialty of commercial installations. In the catalogue are numerous half-tone illustrations, showing towboats, freighters, schooners, launches, oyster boats, etc., in various parts of the world, which have been equipped with Wolverine motors.

"From the Scrap Heap to the Drill Press" is the title of folder 19-H published by the Cleveland Twist Drill Company, Cleveland, Ohio. In this folder the statement is made that any taper shank drill with its tank twisted off can be restored to its original usefulness more easily and more quickly than you can grind its point when dull. "Three minutes' grinding puts on a new and stronger tang below the one that is twisted off. The new tang fits the lower slot."

Turbines for marine and stationary use are described in a large new catalogue just published by the Kerr Turbine Company, Wellsville, N. Y. All of our readers interested in the subject of turbines should send for a free copy of this catalogue. One user of Kerr turbines writes to the manufacturer: "There has been no money spent for maintenance of the turbines and no money spent on attention. They are started by the oiler, bearings examined once every eight hours and the turbine looked over. The oil in the bearings is changed monthly, otherwise they take care of themselves."

"Appliances for Burning Fuel Oil" is the title of a handsomely printed and illustrated catalogue just published by Tate, Jones & Company, Inc., Pittsburg, Pa. "Oil first came into use as a fuel in the field of steam raising, and in this field it has many distinctive advantages over solid fuels. When properly burned it has no injurious effect on the boiler; on the contrary, the boiler's life is lengthened and the cost of its maintenance is lessened. This applies to both fire and watertube boilers. With oil the temperature is kept constant, and chilling drafts in the fire-box are avoided because the furnace doors are never opened while running. Better regulation can be obtained, and overloads or a sudden decrease in load can be instantly taken care of. Oil gives a smokeless fire and leaves no ashes. There are no flues to clean, no clinkers to remove, and no grate-bars to replace. The transmission of heat is at a maximum at all times, as there is no insulating layer of soot deposited on flues and tubes. A greater evaporation per square foot of heating surface is obtained and a saving of about 25 percent in labor. Besides these advantages, we have a reduction of about 40 percent in weight and of about 35 percent in bulk of the fuel, which is of great importance in marine and locomotive work. The economy in fuel of using oil will differ in different localities, depending on the prices of oil and coal, but there are fundamental economies with oil which are shown by the advantages enumerated above, and also from the fact that oil is more easily handled than coal, can be stored at less cost, does not deteriorate when stored and there is no danger of spontaneous combustion. In localities where oil is plentiful there is no question as to its economy as a fuel, but even in localities where oil is comparatively expensive, it is being widely used in a great many industries where the improved product of the manufactured article more than counterbalances the difference in price of the two kinds of fuel. It lends itself particularly well to the operation of metallurgy, because a clean heat is secured as well as a uniform temperature. In the smelting of ores and refining and working of metals the comparative freedom from sulphur of most kinds of oil, and the fact that either an oxidizing, reducing or neutral atmosphere may be maintained, makes it an ideal fuel. Forging and heating of all kinds can be started up and shut down instantly with fuel oil, and we have an early attainment of the maximum temperature with accurate and easy regulation, which is very desirable."

"S & N" heavy-duty beam shears, coping machines and bar and angle cutters, are the subject of a handsomely printed 32-page catalogue just published by the Wiener Machinery Company, Church street, corner Dey street, New York. In this catalogue the following description is given of the "S & N" type T-40, motor-driven, heavy-duty beam shears: "For many years this machine has been considered a standard tool, inasmuch as it has been found so satisfactory by hundreds of customers all over the world. This type is of particular interest to fabricators of structural work, iron and steel dealers and metal manufacturers. Our type T machine combines utmost strength with greatest simplicity. The actual cutting requires less time than any friction saw. It possesses all advantages of a special tool without having the disadvantage of being complicated, so that any man can handle it. The design is heavy and massive. All dimensions are ample to secure working without breakdowns of any kind. The frame consists of very heavy rolled steel plates, which are machined on the inside before being riveted together, so that the inner working mechanism has smooth guiding surfaces. Bushings, bolts, etc., have good and substantial bearing, and repairs will be practically unnecessary. The working parts are of forged and, wherever necessary, hardened steel. Gearing is made of high-grade cast steel with cut teeth, and consequently the machine will run smoothly and noiselessly. The knives of the 'S & N' beam shears are made of the finest tool steel, and the quality, together with the design, makes the knives last for many years. The 'S & N' heavy-duty beam shears cut beams and channels without the necessity of turning them over, the same knives being used for different shapes. The 'S & N' beam shears require one-fifth to one-third of the power of high-speed saws, and still cut faster than these. After the cut is made, the beam cut by an 'S & N' machine is ready for shipment, while the beam sawed has to be freed of the fin. There is no screwing required when placing a beam in an 'S & N' shear. The machine is always ready; the upper knife returns automatically into its initial position after a cut has been made. The operator does not leave his place in front of the machine. The price of a complete installation of 'S & N' beam shears, including all the knives, motor and foundation, is less than that of high-speed saws or of hydraulic machines, while the operating expenses of the 'S & N' machines is far below that of any other tools for the same purpose."

"Regrinding Valves" are the subject of a book of questions and answers issued by the National Tube Company, Frick building, Pittsburg, Pa. The N. T. C. regrinding valve has been on the market for some years. "From time to time certain questions are asked, and we have endeavored in this pamphlet to give replies to the most common queries."

A bolt heading, or forging furnace, which uses oil or gas fuel is described in a catalogue published by Tate, Jones & Company, Pittsburg, Pa. This furnace is especially designed for light forging, and is simple in design, being built of cast iron plates bolted together and lined with asbestos board and firebricks. It is built to heat stock up to 4 inches square, and will make heats 50 inches long. The burners fire from below the work and the material is heated quickly and uniformly.

"Chicago Pneumatic Compressors for Air and Gas" is the title of a booklet issued by the Chicago Pneumatic Tool Company, Fisher building, Chicago, Ill. "To convey at a glance an idea of the wide range of compressors we manufacture is the sole purpose of this brochure. A selection only of our line of 200 types and sizes is herein illustrated in miniature, with a few words by way of description. We publish a complete series of bulletins describing in detail all types of Chicago pneumatic compressors. These and full specifications will be sent upon request made to our nearest office."
and Lundin boats and other lifesaving appliances at the meeting of the Lifeboat Board, Oct. 23, at Newport News, Va. The company also had standard davits and a new Welin boat

TRADE PUBLICATIONS

GREAT BRITAIN

A tool steel testing machine for testing the cutting efficiency of tool steel is made by Edward G. Herbert, Ltd., Atlas Works, Levenshulme, Manchester. "This machine provides for the first time a means of rapidly and accurately ascertaining the actual cutting properties of tool steels; their durability at various speeds; their suitability for different duties; the best methods of hardening them, and the comparative value of various cutting compounds. The durability of tool steel is measured by the number of inches it will turn from a standard test tube of tough steel before the cutting edge becomes worn by a definite amount."

Belting, packing, etc., are the subject of a 42-page catalogue published by Small & Parkes, Ltd., Hendham Vale Works, Manchester. "Having devoted over thirty years to manufacturing engine packings, we can justly claim to be specialists in this important line. We offer you the results of our experience, and if you entrust your packing to us we are confident of being able to save you money, time and trouble. We do not offer one packing designed to suit every requirement, but we make modifications to cope with the different classes of work."

Electric winches, capstans and haulage gears are described in list 14-B, published by Clarke, Chapman & Company, Ltd., Victoria Works, Gateshead-on-Tyne. "In issuing this list it is our desire to illustrate and describe some of the more usual of the many designs of winches, windlasses, capstans, haulage and winding gears which we supply, in the hope that our friends may find therein something that will help them in the selection of such a plant. The very varying conditions under which this class of plant has to work and the very rough usage to which it is often subjected, make special precautions necessary in some cases which can well be dispensed with in others, so that it is difficult to give prices in a list of this kind that would be of any general utility, but we are always pleased to carefully consider inquiries when full particuars of the duty required and conditions of workings are submitted to us."

Gas engines and suction gas plants are described in a catalogue published by Kynoch, Ltd., Witton, Birmingham. "In this catalogue we refer to the high standard of workmanship and material employed in the construction of our gas engines, and venture to point out that our facilities for maintaining this standard are quite exceptional in the gas engine trade. While our gas engine works are distinct, and were specially equipped and staffed for this branch of engineering, we employ a large staff of expert metallurgists, chemists, tool designers and makers, with suitable apparatus for the examination and testing of material in connection with our important iron, copper and brass mills (our large foundries producing enormous castings), and several other engineering shops. For the above reasons we are also able to secure supplies of the highest standard of material, and it will be obvious that this is an advantage to our customers which cannot be offered by all firms engaged in the manufacture of gas engines alone."

BUSINESS NOTES

AMERICA

A Story for Engineers.—"McAndrews' Floating School" begins in this number of International Marine Engineering. It is much easier to read a good story and remember the thousand and one ludicrous incidents than to study a serious textbook. Thousands of men hesitate to read such a book, and it is for these men that "McAndrews' Floating School" is written. The oilers and firemen who figure in this engineering story start in at the very beginning, below the grating of a steamship, and work up step by step. They have many amusing experiences before acquiring the knowledge necessary to take out their first papers. All that the law requires them to know to get their licenses, either from the Board of Trade or the United States Steamboat Inspection Service, is woven into the story, so that the reader unconsciously absorbs a vast amount of practical and necessary information. The object of "McAndrews' Floating School" is to make it possible for a man who wants to secure a marine engineer's license to absorb the necessary information, and enjoy the operation so much that he does not realize that he is studying hard. He only realizes that he is reading the best and most amusing story ever written for engineers. The author is Capt. C. A. McAllister, engineer-in-chief of the Revenue Cutter Service—one of the best-known writers on marine engineering subjects. Many of our readers will remember Capt. McAllister's splendid story for marine engineers entitled "The Professor on Shipboard." Inspector-General George Uhler, of the Steamboat Inspection Service, writes: "I have read the first two chapters of 'McAndrews' Floating School,' written by Capt. C. A. McAllister, of the Revenue Cutter Service. It is written in his usual happy vein, and with his intimate knowledge of every feature of the subject, its purpose and its designed effect, it cannot fail to be interesting to everyone, and particularly useful and helpful to the beginner, who is the child of his thought and the beneficiary of his expression. The idea of putting out what promises to be a textbook in the shape of an interesting story could have had its inception only in the mind of Chief McAllister. Nobody else in the world would have ever thought of such a thing, and I sincerely hope that it may receive all the credit that its excellence and importance deserve."

The Application of Marine Glue to the Beams of Decks.—L. W. Ferdinand & Company, 301 South street, Boston, Mass., are sending out the following instructions regarding the application of Jeffery's marine glue: "Do not attempt to heat all the marine glue you expect to use at once. Heat only what is necessary for immediate use, and as soon as it is half used out of the kettle add fresh glue, keeping it stirred now and then. It should be used as soon is it is melted and not allowed to stand in the kettle. Continued boiling hardens and injures the glue. Almost without exception, unsatisfactory results in using this material are occasioned by faulty application and are produced entirely by two causes. First, if either the oakum or cotton calking or the seam is damp when the glue is applied, as soon as the sun shines on the deck the heat will turn this moisture into steam which will force the glue up over the edge of the seam. Second, in paying the seam the ladle should be held at least an inch above the deck—if the ladle is drawn on or close to the seam a quantity of atmosphere will envelop, and has no time to escape before the glue becomes set. This will cause air bubbles, which in hot weather will also force the glue up over the edge of the seam, leaving it hollow and unsound. The seams must be absolutely dry and clean before the glue is run into them. If applied to old work, the old material should be dug out perfectly clean. Whatever adheres to the sides should be removed with a rase knife."

The Welin Marine Equipment Company, Long Island City, N. Y., had a complete exhibit of models of Welin davits and Lundin boats and other lifesaving appliances at a meeting of the Lifeboat Board, Oct. 23, at Newport News, Va. The company also had standard davits and a new Welin boat installed for test on board the transport *Kilpatrick*. Mr. Axel Welin came over from England to be present at these practical tests, which were made under the direction of the board. The model of the arrangement of the lifeboats and davits, as supplied by the London house of this company for the new Hamburg-American liner *Imperator*, was most interesting, and the very difficult problem of stowing the necessary lifeboats with the crew of such an immense ship and its passengers seems to have been most admirably settled. The large order for lifeboats made under the new rules of the Board of Supervising Inspectors is now being rapidly filled by the Welin Marine Equipment Company for the New England Navigation Company, and the quadrant davits for the *Commonwealth*, *Priscilla*, *Providence* and *Plymouth* are partly installed on these steamers. Capt. A. P. Lundin, president of the company, goes soon to the Pacific Coast to be present at the tests which are to be undertaken for lifesaving appliances.

Marine Refrigerating Plants.—The Brunswick Refrigerating Company, New Brunswick, N. J., writes us, under date of Nov. 15, regarding an order received from Barber & Company, 17 Battery Place, New York: "We have just received an order from Barber & Company for the installation of one of our 1-ton plants on board the steamship *Shimosa*. This is the standard Brunswick direct-connected outfit for cooling a little box 8 by 7 by 6 feet high inside. The *Shimosa* sails for the Far East, Singapore and the Red Sea, on the 24th. The order was entered Nov. 14, yesterday, and be assured that the boat will sail with the plant running properly after a good test run, even if there are only nine days to do the work in. As soon as the job is finished we will write and give you more details. This machine will operate under the most trying conditions, the temperature of the condensing water is very high, and also the temperature of the atmosphere is high and the humidity great. The effect of the warm condensing water is counterbalanced by the installation of an especially large ammonia condenser. In spite of the fact that the machine is only 1-ton capacity, the condenser will be 15 feet long, 4 pipes, 1¼-inch and 2-inch pipes. The refrigerator will be built of 2-inch compressed corkboard, with lumber on either side, and three more thicknesses of lumber, making two 1-inch air spaces. The various thicknesses of lumber will be backed up by fourteen thicknesses of two-play heavy insulating waterproof paper. The insulation over all will be about 8 inches thick, and will be built for holding a temperature of 20 degrees in the refrigerator, with an outside temperature of 90 degrees. This is a typical little Brunswick job, just the kind of work that the Brunswick Refrigerating Company is looking for. It does not make any difference how small the boat is or how little room there is on it, there is room for a Brunswick, and a Brunswick may be operated economically wherever 50 pounds of ice a day is used for refrigerating purposes."

WALTER B. SNOW, publicity engineer, 170 Summer street, Boston, Mass., has recently increased his staff by the addition of Fred. R. Lufkin, formerly of the instructing staff in electrical engineering of the Massachusetts Institute of Technology, and late assistant superintendent of lighting and wires, Brookline, Mass.

NEUTRALIZING FIRE AFLOAT.—A number of recent serious fires on ships have called attention once more to the fact that perhaps the greatest dread of all those who "go down to the sea in ships" is the ever-present menace of fire. It does not need the example of the *General Slocum* to point the moral that adequate advance preparation is the only real security. The latest and largest passenger steamer on the Great Lakes, the *City of Detroit III.*, has been protected against this possibility by a system of Grinnell automatic sprinklers, which covers all the vulnerable parts of the vessel, and provides a certain and complete answer to any fire which might originate. These are distributed throughout the cargo and baggage spaces, in the pantries and galleys, and in all other locations where the nature of the contents would be liable to cause trouble. In addition to the sprinklers there is a complete fire alarm system throughout the vessel; the hull, including the large deckhouse, is subdivided by fireproof partitions and fire doors, so that in those portions where the sprinkler protection is not available the spread of a fire would be so completely limited that the crew would have a comparatively easy task in coping with it. The main reliance, however, is placed, as always, upon the automatic means for both discovering and extinguishing fire. The alarms, showing on the annunciator the location of each incipient blaze, and the sprinklers, putting it out before it can gather headway, form the only complete answer to the fire problem as it exists afloat.

BUSINESS NOTES

GREAT BRITAIN

THE ENGINEERING AND MACHINERY EXHIBITION which was held at Olympia from Oct. 4 to 26 was unusually successful. Among the large number of representative firms who exhibited we notice the following: *James Archdale & Company, Ltd., Birmingham,* exhibited machine tools of the most recent design, arranged for the use of high-speed cutting steel tools, all driven under working conditions by electric motors, thus eliminating all overhead shafting and its attendant belting. *H. W. Ward & Company, Ltd.,* Birmingham, showed a representative selection of their capstan and turret lathes, milling machines and ball bearing drills. *Vickers, Ltd.,* Vickers House, Broadway, Westminster, London, S. W., showed a large assortment of electrical machinery, such as motors of various types, high-power drills, adjustable reamers, etc. *At the stand of Hans Renold, Ltd.*, Progress Works, Brook street, Manchester, every department of power transmission by chain was effectively represented. These chains may be briefly classified under the three heads of silent, roller and block. *A. Herbert, Ltd.,* Coventry, had two stands showing a number of up-to-date labor-saving machine tools also a number of small tools. *Henry Pels & Company,* Lincoln Chambers, 9 Portsmouth street, Lincoln's Inn Fields, London, W. C., exhibited a number of machine tools, such as joist shears combined with a universal punching machine; a double-ended universal punching and shearing machine combined with a bar, angle, tee and channel cropper; a universal multiple punching machine, etc. *The Crosby Steam Gage & Valve Company,* 147 Queen Victoria street, London, E. C., exhibited, among other engineering specialties, a relay reducing valve, a British-made recorder and Wallace & Lanza indicator attachments. *Arthur Ross, Hotchkiss & Company, Ltd.,* 1 Glengall Road, Old Kent Road, London, S. E., exhibited the Hotchkiss circulator for marine boilers, a new condenser ferrule, a new watertube boiler, and "Ross' Composition" for removing and preventing boiler scale. *Mayer & Schmidt,* Offenbach-on-Main, Germany, exhibited grinding machinery for railway and locomotive works. Marine circulators were shown by the *Ross Schofield Company,* 117 Leadenhall street, London, E. C. *Clarke, Chapman & Company, Ltd., Victoria Works,* Gateshead-on-Tyne, had a large exhibit of electrical machinery, watertube boilers, winches, windlasses, engines, projectors, etc. *Kynoch, Ltd.,* Lyon Work Works, Witton, Birmingham, exhibited an electric light engine with producer plant, completely furnished on the stand, with a 1-95 brake-horsepower engine, which was running. *W. H. Bailey & Company, Ltd.,* Albion Works, Salford, Manchester, made a very interesting display of pumps, air compressors and steam and water fittings.

J. W. Brooke & Company, Ltd., Adrian Works, Lowestoft, report a very flourishing business in marine motors, writing: "We have, unfortunately, got slightly behind with deliveries, and we still have eighty motors on order for completion, aggregating 2,500 horsepower, a large proportion of which are for shipment to our agents abroad. In addition to this we have just dispatched three teak launches to the Egyptian Government, and on the stock are several launches to be shipped to India."

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

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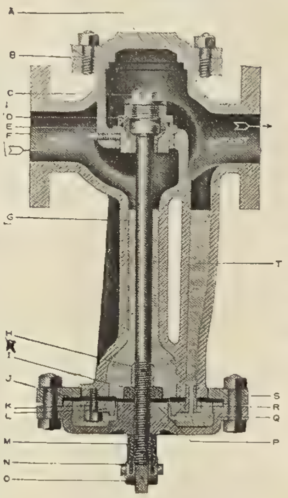

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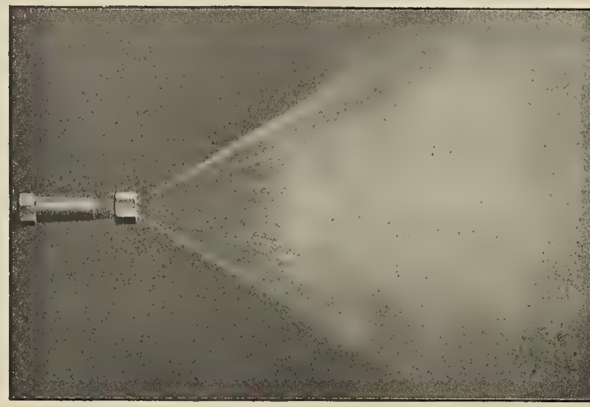

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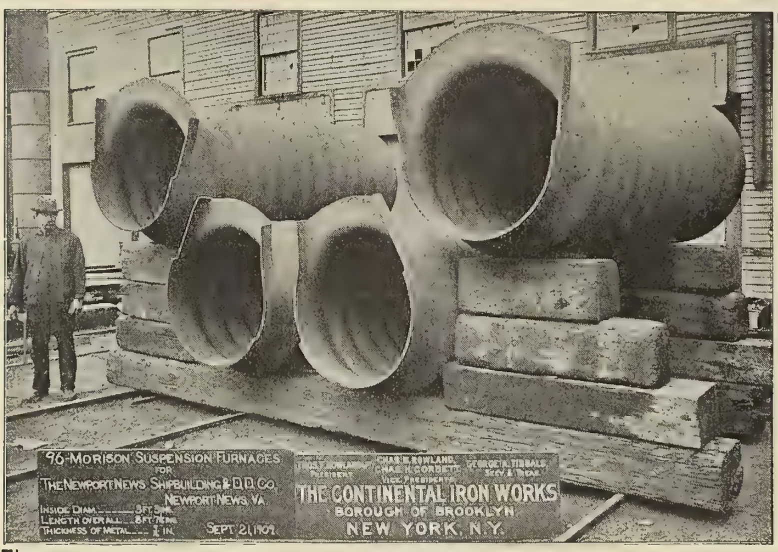

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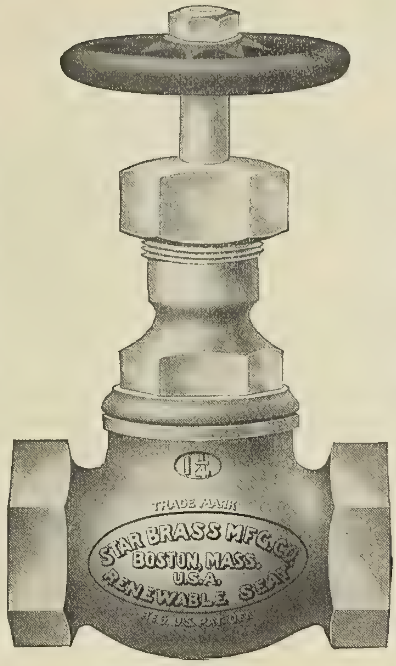

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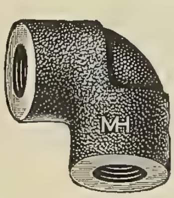

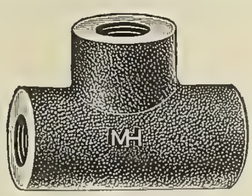

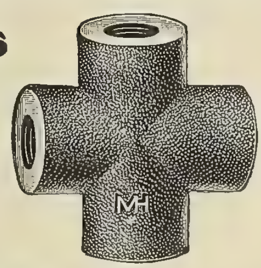

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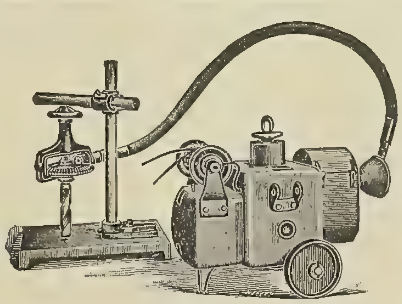

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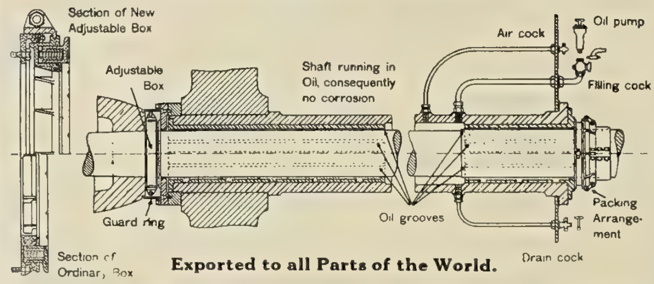

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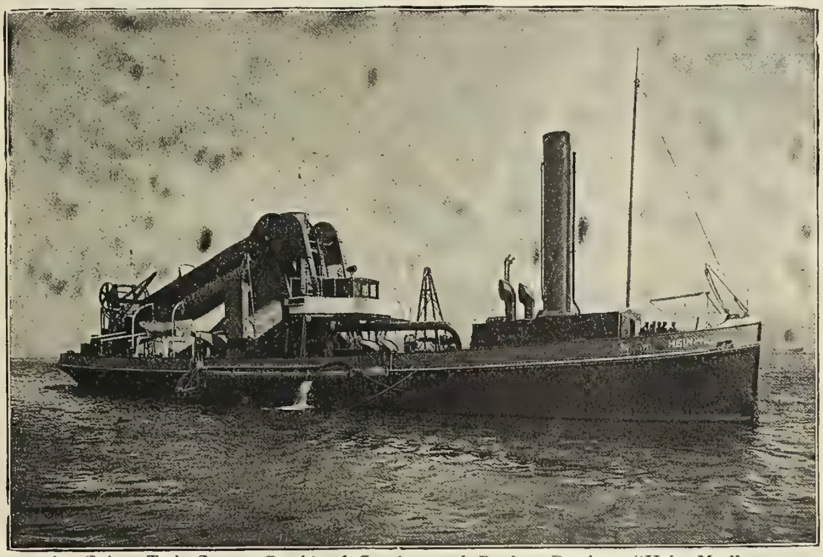

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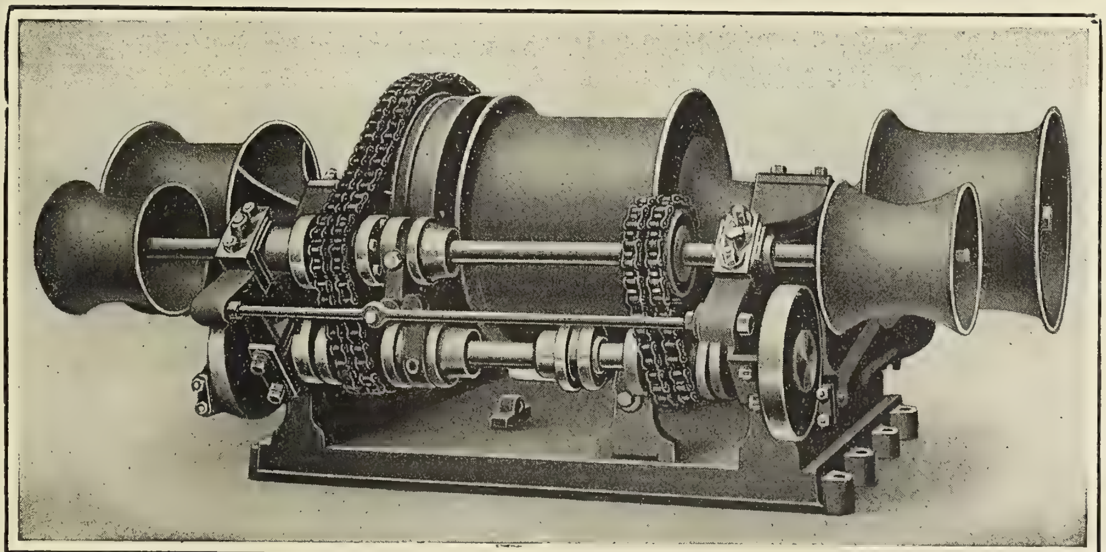

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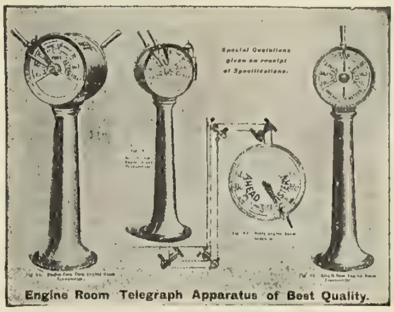

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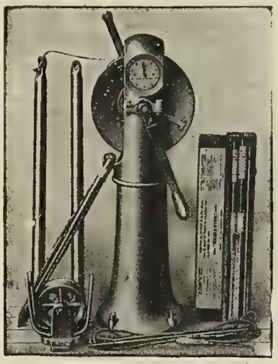

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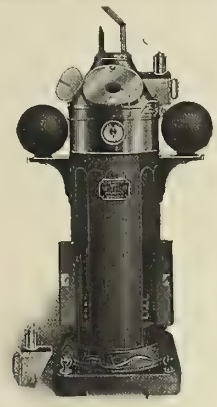

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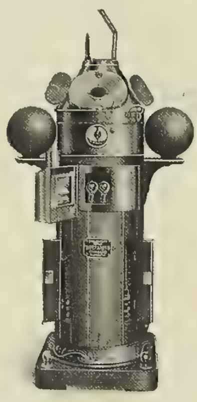

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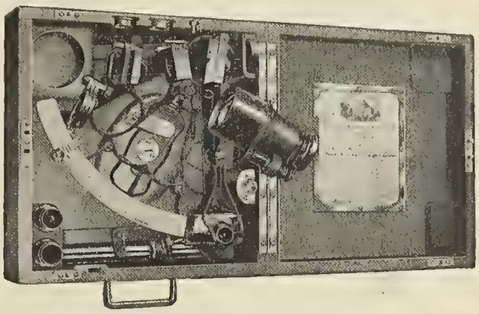

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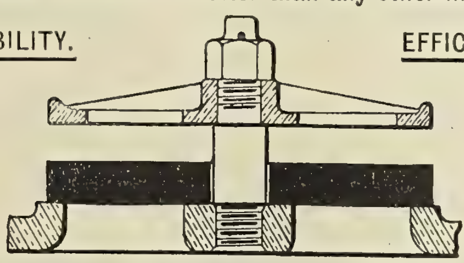

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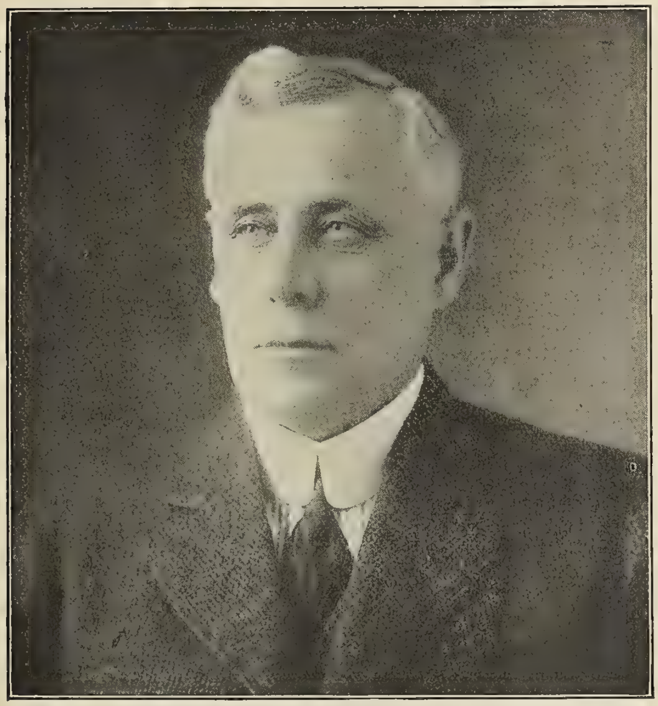

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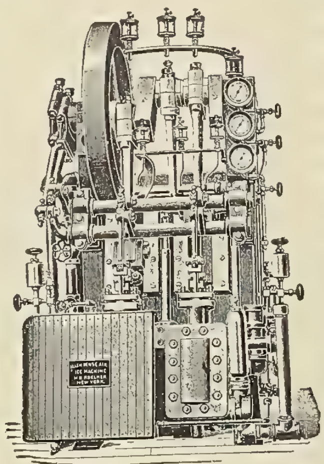

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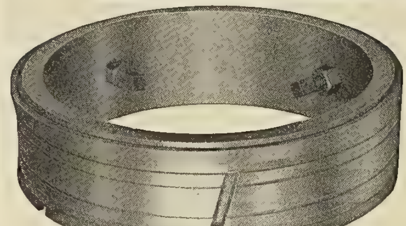

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BOILERS—Also see ENGINE BUILDERS—also SHIP BUILDERS.
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Babcock & Wilcox Co., New York.
Bath Iron Works, Bath, Maine.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Mosher Water Tube Boiler Co., New York.
Robb Engineering Co., South Framingham, Mass.
Ward, Chas., Engineering Works, Charleston, W. Va.

BOILER CIRCULATORS.
Ross Schofield Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

BOILER COMPOUNDS.
Johns-Manville, H. W., Co., New York.

BOILER COVERING—See NON-CONDUCTING COVERING.

BOILER FEEDERS—See FEED-WATER REGULATORS.

BOILER-FLUE AND TUBE CLEANERS.
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Griscom-Russell Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

BOILER FLUE AND TUBE CUTTERS.
Griscom-Russell Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

BOILER AND PIPE COVERINGS—See NON-CONDUCTING COVERING.

BOILER RIVETS—Also see RIVETS.
Champion Rivet Co., Cleveland, Ohio.

BOILER ROOM FITTINGS.
American Blower Co., Detroit, Mich.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Diamond Power Specialty Co., Detroit, Mich.
Griscom-Russell Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Lytton Mfg. Corp., Franklin, Va.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Watertown Specialty Co., Watertown, N. Y.

BOILER STAYBOLTS—See STAYBOLTS.

BOILER TUBES.
National Tube Co., Pittsburg, Pa.

BOILER TUBE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

BOILER TUBE RETARDERS.
Griscom-Russell Co., New York.

BOLTS AND NUTS.
National Tube Co., Pittsburg, Pa.

BOOKS.
Co-operative Publishing Co., Baltimore, Md.

BORING BARS—See CYLINDER BORING BARS.

BORING MACHINES—METAL WORKING.
Niles-Bement-Pond Co., New York.

BORING MACHINES—WOOD.
Independent Pneumatic Tool Co., Chicago and New York.

BORING AND TURNING MILLS.
Niles-Bement-Pond Co., New York.

BRASS AND COPPER—Also see YELLOW METAL; also MUNTZ METAL.
Biddle Hardware Co., Philadelphia, Pa.

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Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.

BRASS FITTINGS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Biddle Hardware Co., Philadelphia, Pa.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

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Smooth-On Mfg. Co., Jersey City, N. J.

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Phosphor-Bronze Smelting Co., Philadelphia, Pa.

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BRONZE-VANADIUM.
American Vanadium Co., Pittsburg, Pa.

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Sands, A. B., & Son Co., New York.

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BUOYS, RING.
Ferdinand, L. W., & Co., Boston, Mass.

BURNERS, FUEL OIL—See FUEL OIL BURNERS.

BUSHINGS.
National Tube Co., Pittsburg, Pa.

BUTTERFLY VALVES—See VALVES.

BY-PASS VALVES—See VALVES.

CABLES—See CHAIN, also ROPE.

CABLEWAYS—See MARINE CABLEWAYS.

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Wilford Cloth Co., New York.

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Hyde Windlass Co., Bath, Maine.

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CASTINGS—BRONZE—Also see STEEL CASTINGS.
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Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

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American Vanadium Co., Pittsburg, Pa.

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Ferdinand, L. W., & Co., Boston, Mass.

CENTRIFUGAL PUMPS—See PUMPS.

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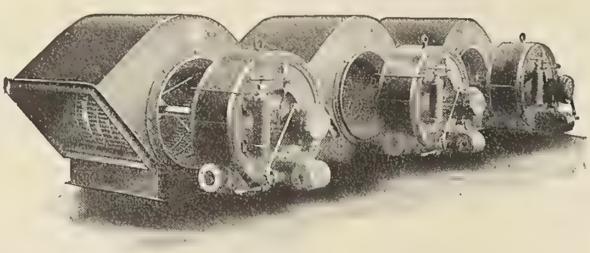

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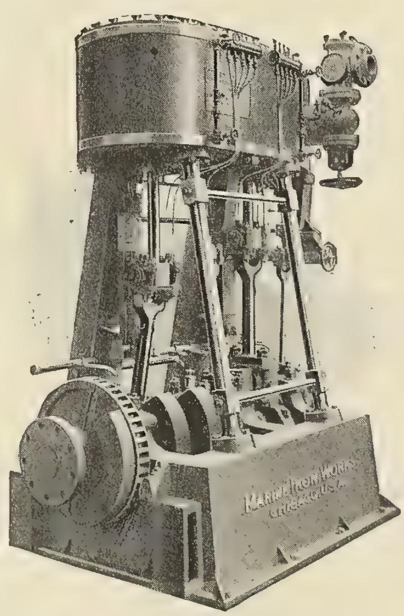

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Durable Wire Rope Co., Boston, Mass.
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Plymouth Cordage Co., North Plymouth, Mass.

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COTTON RUBBER-LINED HOSE—See HOSE.

COUNTERS—See REVOLUTION COUNTERS.

COVERING, STEAM—See NON-CONDUCTING COVERING.

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American Engineering Co., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Welin Marine Equipment Co., Long Island City, N. Y.

CRANK SHAFTS—See FORGINGS.

CUPRO-VANADIUM.
American Vanadium Co., Pittsburg, Pa.

CUTTERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

CYLINDER BORING BARS.
Niles-Bement-Pond Co., New York.

CYLINDER RELIEF VALVES—See VALVES.

CYLINDERS FOR COMPRESSED AIR, GAS, ETC.
National Tube Co., Pittsburg, Pa.

CYLINDERS, VANADIUM.
American Vanadium Co., Pittsburg, Pa.

DAMPER REGULATORS.
Diamond Power Specialty Co., Detroit, Mich.

DAVITS.
Welin Marine Equipment Co., Long Island City, N. Y.

DECK HOISTS—See HOISTING ENGINES.

DECK PLATES.
Sands, A. B., & Son Co., New York.

DECK PUMPS—See PUMPS.

DIAPHRAGM PUMPS—See PUMPS.
Hyde Windlass Co., Bath, Maine.

DIES.
Morse Twist Drill & Machine Co., New Bedford, Mass.

DIESEL ENGINES.
Carels Frères, Ghent, Belgium; and New York.

DIRECT-CONNECTED SETS—See ELECTRICAL PLANTS.

DISENGAGING GEARS.
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DISTILLERS—See EVAPORATORS.

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Morse, Andrew J., & Son, Inc., Boston, Mass.

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DRILLS, PNEUMATIC—See PNEUMATIC TOOLS—Also AIR DRILLS.

DRILLS, PORTABLE—See PORTABLE DRILLS.

DROP FORGINGS—EYE BOLTS, HOOKS, ROPE SOCKETS, WRENCHES, ETC.
Sizer Forge Co., Buffalo, N. Y.
Williams & Co., J. H., Brooklyn, N. Y.

DROP HAMMERS.
Niles-Bement-Pond Co., New York.

DRY DOCKS AND MARINE RAILWAYS.
Krajewski-Pesant Corporation, Havana, Cuba.
Merrill-Stevens Co., Jacksonville Fla.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Tietjen & Lang Dry Dock Co., Hoboken, N. J.

DRY DOCKS—MARINE RAILWAY—MANUFACTURER.
Crandall Engineering Co., The, East Boston, Mass.

DRYING APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

DYNAMOS—See ELECTRIC PLANTS; also STEAM TURBINE DYNAMOS.

ECONOMIZERS, FUEL—See FUEL ECONOMIZERS.

EJECTORS.
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Schutte & Körting Co., Philadelphia, Pa.

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Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

ELECTRIC HEATERS.
General Electric Co., Schenectady, N. Y.
Simplex Electric Heating Co., Cambridgeport, Mass.

ELECTRIC HOISTS.
American Engineering Co., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Niles-Bement-Pond Co., New York.

ELECTRIC LIGHTS.
General Electric Co., Schenectady, N. Y.

ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
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ELECTRICAL FITTINGS AND SUPPLIES—Also see ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
Griscom-Russell Co., New York.
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ELECTRICAL INSTRUMENTS.
General Electric Co., Schenectady, N. Y.
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ELEVATORS, FREIGHT—See FREIGHT ELEVATORS, also INCLINED ELEVATORS.

ENGINE PACKING—See PACKING.

ENGINE-ROOM SUPPLIES—See STEAM SPECIALTIES.

ENGINEERS, CONSULTING AND CONTRACTORS.
American Engineering Co., Philadelphia, Pa.
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ENGINES, GASOLINE—See GASOLINE ENGINES.

ENGINES, HOISTING—See HOISTING ENGINES.

ENGINES, KEROSENE—See KEROSENE ENGINES.

ENGINES, OIL—See also DIESEL ENGINES.
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Wolverine Motor Works, Bridgeport, Conn.

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Carels Frères, Ghent, Belgium and New York.
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Sheriffs Mfg. Co., Milwaukee, Wis.
Trout, H. G., Co., Buffalo, N. Y.
Ward, Chas., Engineering Works, Charleston, W. Va.

ENGINE REGISTERS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINE-ROOM CLOCKS—See CLOCKS.

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Wheeler Condenser and Engineering Co., Carteret, N. J.

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EXHAUST FANS—See BLOWERS.

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Sturtevant Co., B. F., Hyde Park, Mass.

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Wheeler Condenser and Engineering Co., Carteret, N J.

FEED-WATER REGULATORS.
Alberger Pump and Condenser Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.

FERRO-VANADIUM.
American Vanadium Co., Pittsburg, Pa.

FERRY BOAT LAMPS—See LAMPS.

FILES.
Nicholson File Co., Providence, R. I.

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FIRE EXTINGUISHERS.
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FIREPROOF CONSTRUCTION.
Johns-Manville, H. W., Co., New York.

FIREPROOF LUMBER—See LUMBER, FIREPROOF.

FIRE PUMPS—See PUMPS.

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FUEL OIL BURNERS.
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Griscom-Russell Co., New York.
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Katzenstein & Co., L., New York.
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Peerless Rubber Mfg. Co., New York.
Power Specialty Co., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

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Bridgeport Motor Co., Bridgeport, Conn.
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Standard Motor Construction Co., Jersey City, N. J.
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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
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GATE VALVES—See VALVES.

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American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Jerguson Gage & Valve Co., Boston, Mass.
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Watertown Specialty Co., Watertown, N. Y.

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American Steam Gauge and Valve Mfg. Co., Boston, Mass.

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GRABS—See DREDGING MACHINES.

GRAPHITE.
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GREASE CUPS—See LUBRICATORS.
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HARDWOOD—See LUMBER.

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Schutte & Körting Co., Philadelphia, Pa.

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HEMP—See TWINE.

HOISTING ENGINES.
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Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.

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HOISTS, ELECTRIC—See ELECTRIC HOISTS.

HOSE—See AIR HOSE.
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Independent Pneumatic Tool Co., Chicago and New York.
New York Belting & Packing Co., Ltd., New York.

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Eureka Fire Hose Co., New York.
Hayward, S. F., & Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.

HOSE NOZZLES.
Hayward, S. F., & Co., New York.
McNab & Harlin Mfg. Co., New York.
Morse, Andrew J., Son, Inc., Boston, Mass.

HOSE REELS AND RACKS.
Hayward, S. F., & Co., New York.

HUMIDIFIERS.
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Tillotson Humidifier Co., Providence, R. I.

HYDRAULIC FITTINGS.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

HYDRAULIC MACHINERY—RIVETERS, PUNCHES, SHEARS.
Niles-Bement-Pond Co., New York.

ICE MACHINES—See REFRIGERATING PLANTS.

INCLINED ELEVATORS FOR DOCKS AND WHARVES.
Otis Elevator Co., New York.

INDICATOR CONNECTIONS.
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INDICATORS—STEAM AND GAS ENGINE.
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Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

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American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

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Powell Co., The, Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

INSURANCE—MARINE AND FIRE.
Hutchinson, Rivinus & Co., New York and Philadelphia.

INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
New York Belting & Packing Co., Ltd., New York.

IRON CEMENT.
Smooth-On Mfg. Co., Jersey City, N. J.

JACKS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

JOURNAL BEARINGS—See THRUST BEARINGS.

JUTE.
Columbian Rope Co., Auburn and New York.

KEROSENE ENGINES—See also OIL ENGINES AND DIESEL ENGINES.
Mietz, A., New York.
Wolverine Motor Works, Bridgeport, Conn.

LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.

LAMPS, SIGNALS, AND FIXTURES.
Carlisle & Finch Co., Cincinnati, Ohio.
General Electric Co., Schenectady, N. Y.
Johns-Manville, H. W., Co., New York.

LATHES, ENGINE.
Niles-Bement-Pond Co., New York.

LATHES, TURRET.
Niles-Bement-Pond Co., New York.

LAUNCHES AND YACHTS—See also SHIPBUILDERS AND DRY DOCK COMPANIES.
Bridgeport Motor Co., Bridgeport, Conn.
Marine Iron Works, Chicago, Ill.
Standard Motor Construction Co., Jersey City, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.
Welin Marine Equipment Co., Long Island City, N. Y.

LAVATORIES—FOLDING, STATIONARY, STATEROOM.
Sands, A. B., & Son Co., New York.

LAVATORY AND BATH HEATERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

LIFE BOATS AND RAFTS.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE GUNS.
Hayward, S. F., & Co., New York.

LIFE PRESERVERS.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE-SAVING DEVICES.
Hayward, S. F., & Co., New York.
Welin Marine Equipment Co., Long Island City, N. Y.

LIGHTS.
Milburn, Alex. C., Co., Baltimore, Md.

LIGHT BUOYS.
Milburn, Alex. C., Co., Baltimore, Md.

LIGHTHOUSE APPARATUS.
Milburn, Alex. C., Co., Baltimore, Md.

LINOLEUM CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

LIQUID GLUE, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

LOG REGISTERS.
Schuette Recording Compass Co., Manitowoc, Wis.
Welin Marine Equipment Co., Long Island City, N. Y.

LUBRICANTS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Power Specialty Co., New York.

LUBRICATING COMPOUND.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.

LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

LUMBER.
Vrooman, S. B., Co., Philadelphia, Pa.

MACHINE TOOLS—See TOOLS, MACHINE.

MAHOGANY—See LUMBER.

MANGANESE BRONZE CASTINGS—Also see BRONZE.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

MAGNESIA COVERINGS.
Johns-Manville, H. W., Co., New York.

MANILA AND SISAL ROPE—See ROPE; also CORDAGE.

MARINE BOILER COMPOUNDS—See BOILER COMPOUNDS.

MARINE CABLEWAYS.
Lidgerwood Mfg. Co., New York.

MARINE ENGINES—See ENGINES, PROPELLING.

MARINE FORGINGS—See FORGINGS.

MARINE GAS PRODUCERS.
Griscom-Russell Co., New York.
Marine Producer Gas Power Co., New York.
Wolverine Motor Works, Bridgeport, Conn.

MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

MARINE HARDWARE.
Griscom-Russell Co., New York.
Biddle Hardware Co., Philadelphia, Pa.
Ferdinand, L. W., & Co., Boston, Mass.

MARINE LAMPS—See LAMPS.

MARINE PAINT.
Toch Bros. New York.

MARINE RAILWAY BUILDERS—See RAILWAY DRY DOCKS.
Crandall Engineering Co., The, East Boston, Mass.

MARINE RANGES—See RANGES.

MARINE REFRIGERATION—See REFRIGERATING PLANTS.

MARINE SIGNALS—See SIGNALS.

MARINE SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.

MASTS, STEEL.
Welin Marine Equipment Co., Long Island City, N. Y.

MECHANICAL DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

MEGAPHONES—See CHANDLERY STORES.

METAL WORKING TOOLS—See TOOLS, MACHINE.

METALLIC PACKING—Also see PACKING.
Katzenstein, L., & Co., New York.
Power Specialty Co., New York.
Rooksby, E. J., & Co., Philadelphia, Pa.
United States Metallic Packing Co., Philadelphia, Pa.

METRES, ELECTRIC.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

MILLING MACHINES.
Niles-Bement-Pond Co., New York.

MINERAL WOOL—See NON-CONDUCTING COVERING.

MONEL METAL.
Biddle Hardware Co., Philadelphia, Pa.

MONITOR NOZZLES—See HOSE NOZZLES.

MOORING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

MOTOR BOATS—See LAUNCHES AND YACHTS.

MOTOR BOAT SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.

MOTORS, ELECTRIC.
General Electric Co., Schenectady, N. Y.

MOTORS, GASOLINE—See GASOLINE ENGINES.

MULTIPLE DRILLS.
Niles-Bement-Pond Co., New York.

MULTI-SPEED MOTORS.
Stow Mfg. Co., Binghamton, N. Y.

NAVAL ARCHITECTS—See PROFESSIONAL CARDS.

NEEDLE VALVES—See VALVES.

NIPPLES.
National Tube Co., Pittsburg, Pa.

NON-CONDUCTING COVERING.
Johns-Manville, H. W., Co., New York.

NOZZLES—See HOSE NOZZLES.

NUTS—See BOLTS AND NUTS.

OAKUM.
Baltimore Oakum Co., Baltimore, Md.
Davey, W. O., & Sons, Jersey City, N. J.
Welin Marine Equipment Co., Long Island City, N. Y.

OIL—See LUBRICANTS.

OIL BURNERS, FUEL—See FUEL OIL BURNERS.

OIL CUPS—See LUBRICATORS.

OIL FUEL APPARATUS.
Schutte & Körting Co., Philadelphia, Pa.

OIL ENGINES—See ENGINES, OIL.

OIL GAUGES.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OIL POLISH—See METAL POLISH.

OIL PUMPS.
Lunkenheimer Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OILING SYSTEMS—Also see LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

PACKING—Also see METALLIC PACKING.
- Johns-Manville, H. W., Co., New York.
- New York Belting & Packing Co., Ltd., New York.
- Peerless Rubber Mfg. Co., New York.
- Power Specialty Co., New York.
- Rooksby, E. J., & Co., Philadelphia, Pa.

PACKING, ASBESTOS.
- Johns-Manville, H. W., Co., New York.

PAINT—Also see GRAPHITE; also MARINE PAINT.
- Dixon, Jos., Crucible Co., Jersey City, N. J.
- Toch Bros. New York.

PATENT ATTORNEYS—See ATTORNEYS, PATENT.

PETROL ENGINES—See GASOLINE ENGINES.

PHOSPHOR BRONZE CASTINGS.
- Griscom-Russell Co., New York.
- Hyde Windlass Co., Bath, Maine.
- Lunkenheimer Co., Cincinnati, Ohio.
- Phosphor-Bronze Smelting Co., Philadelphia, Pa.

PILING—STEEL.
- Lackawanna Steel Co., Buffalo, N. Y.

PIPE COVERING—See NON-CONDUCTING COVERING.

PIPE CUTTING AND THREADING MACHINES.
- Niles-Bement-Pond Co., New York.

PIPE FLANGES—See FLANGES.

PIPE UNIONS.
- Dart, E. M., Mfg. Co., Providence, R. I.
- Lunkenheimer Co., Cincinnati, Ohio.
- McNab & Harlin Mfg. Co., New York.
- National Tube Co., Pittsburg, Pa.
- Powell Co., The, Wm., Cincinnati, Ohio.

PIPE WRENCHES.
- McNab & Harlin Mfg. Co., New York.
- Williams & Co., J. H., Brooklyn, N. Y.

PLANERS, STANDARD METAL WORKING AND ROTARY.
- Niles-Bement-Pond Co., New York.

PLANERS, SHIP PLATE.
- Niles-Bement-Pond Co., New York.

PLANIMETERS.
- American Steam Gauge and Valve Mfg. Co., Boston, Mass.
- Star Brass Mfg. Co., Boston, Mass.

PLATE-BENDING ROLLS.
- Niles-Bement-Pond Co., New York.

PLUMBAGO—Also see GRAPHITE.
- Dixon, Jos., Crucible Co., Jersey City, N. J.

PLUMBING—Also see CHANDLERY STORES.
- Davidson, M. T., Co., New York.
- Sands, Alfred B., & Son Co., New York.

PNEUMATIC SEPARATORS.
- Griscom-Russell Co., New York.
- Sturtevant Co., B. F., Hyde Park, Mass.

PNEUMATIC TOOLS—Also see AIR COMPRESSORS.
- Independent Pneumatic Tool Co., Chicago and New York.

POPPET VALVES—See VALVES.

PORTABLE CYLINDER BORING BARS—See CYLINDER BORING BARS.

PORTABLE DRILLS.
- General Electric Co., Schenectady, N. Y.
- Stow Mfg. Co., Binghamton, N. Y.

POWER PUNCHES AND SHEARS—See TOOLS, MACHINE.

PRESSURE REGULATORS.
- American Steam Gauge & Valve Mfg. Co., Boston, Mass.
- Ashton Valve Co., Boston, Mass.
- Lunkenheimer Co., Cincinnati, Ohio.
- Lytton Mfg. Corp., Franklin, Va.
- McNab & Harlin Mfg. Co., New York.
- Powell Co., Wm., Cincinnati, Ohio.
- Star Brass Mfg. Co., Boston, Mass.
- Watertown Specialty Co., Watertown, N. Y.

PRODUCERS—See MARINE GAS PRODUCERS.

PROFESSIONAL CARDS.
- Cox & Stevens, New York.
- Decker, Delbert H., Washington, D. C.
- Donnelly, W. T., New York.
- Whitaker, Morris M., Nyack-on-Hudson, N. Y.

PROJECTORS—See SEARCHLIGHTS.

PROPELLER WHEELS.
- Donnelly, W. T., New York.
- Hyde Windlass Co., Bath, Me.
- Roelker, H. B., New York.
- Sheriffs Mfg. Co., Milwaukee, Wis.
- Trout, H. G., Co., Buffalo, N. Y.

PROPELLING ENGINES—See ENGINES, PROPELLING.

PUMPS.
- Alberger Pump and Condenser Co., New York.
- Blake & Knowles Steam Pump Works, New York.
- Davidson, M. T., Co., New York.
- De Laval Steam Turbine Co., Trenton, N. J.
- Griscom-Russell Co., New York.
- Hyde Windlass Co., Bath, Maine.
- Kingsford Foundry & Machine Works, Oswego, N. Y.
- Sands, A. B., & Son Co., New York.
- Terry Steam Turbine Co., Hartford, Conn.
- Wheeler Condenser and Engineering Co., Carteret, N. J.

PUMPS, DREDGING.
Terry Steam Turbine Co., Hartford, Conn.

PUMPS, MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

PUNCHING MACHINES AND SHEARING MACHINES, HYDRAULIC POWER AND HAND.
Niles-Bement-Pond Co., New York.

PYROMETERS.
H. & M. Division of the Taylor Instrument Cos., Rochester, N. Y.

QUADRANT DAVITS—See DAVITS.

RAFTS—See LIFE BOATS AND RAFTS.

RAILWAY DRY DOCKS.
Crandall Engineering Co., East Boston, Mass.

RANGE FINDERS.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.

RANGES.
Sands, A. B., & Son Co., New York.

RASPS.
Nicholson File Co., Providence, R. I.

REAMERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

REAMERS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

RECORDING COMPASSES.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.

REDUCING VALVES—See VALVES.

REDUCING WHEEL.
American Steam Gauge and Valve Mfg. Co., Boston, Mass.

REFLEX WATER GAUGES.
Jerguson Gage & Valve Co., Boston, Mass.

REFRIGERATING ENGINEERS—See ENGINEERS, CONSULTING.

REFRIGERATING PLANTS.
Brunswick Refrigerating Co., New Brunswick, N. J.
Roelker, H. B., New York.

REGRINDING VALVES—See VALVES.

RELEASING GEAR.
Welin Marine Equipment Co., Long Island City, N. Y.

RELIEF VALVES—See VALVES.

REVOLUTION COUNTERS.
American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.

RHEOSTATS.
General Electric Co., Schenectady, N. Y.
Simplex Electric Heating Co., Cambridge, Mass.

RIGGING—See WIRE ROPE.

RIVER BOATS—Also see SHIPBUILDERS AND DRY DOCK COS.
Marine Iron Works, Chicago, Ill.
Merrill-Stevens Co., Jacksonville, Fla.
Ward, Chas., Engineering Works, Charleston, W. Va.

RIVETS.
Champion Rivet Co., Cleveland, Ohio.

RIVETING MACHINES, HYDRAULIC AND STEAM POWER.
Independent Pneumatic Tool Co., Chicago and New York.
Niles-Bement-Pond Co., New York.

RIVETERS, PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

ROLLER BEARINGS—See THRUST BEARINGS.

ROLLS, BENDING AND STRAIGHTENING.
Niles-Bement-Pond Co., New York.

ROOFING PAINTS.
Ferdinand, L. W., & Co., Boston, Mass.

ROPE—Also see WIRE ROPE, TRANSMISSION ROPE, and MANILA AND SISAL ROPE.
Columbian Rope Co., Auburn and New York.
Durable Wire Rope Co., Boston, Mass.
Griscom-Russell Co., New York.
Phosphor-Bronze Smelting Co., Ltd., Philadelphia, Pa.
Plymouth Cordage Co., North Plymouth, Mass.

ROTARY BLOWERS—See BLOWERS.

ROWBOATS—See LAUNCHES AND YACHTS.

RUBBER BELTING.
Hayward, S. F., & Co., New York.

RUBBER GOODS—Also see Packing—Also see INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
Hayward, S. F., & Co., New York.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., New York.

RUBBER MATTING CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

RUBBER TILING—See INTERLOCKING RUBBER TILING.

RUBBER VALVES—See VALVES, RUBBER.

SAFETY VALVES—See VALVES.

SANITARY FITTINGS—See PLUMBING.

SANITARY PUMPS—See PLUMBING.

SEARCHLIGHTS.
Carlisle & Finch Co., Cincinnati, Ohio.
General Electric Co., Schenectady, N. Y.

SENTINEL VALVES—See VALVES.

SEPARATORS—PNEUMATIC—See PNEUMATIC SEPARATORS.

SHAFTING—HOLLOW, SEAMLESS STEEL.
National Tube Co., Pittsburg, Pa.

SHAFT STEEL—See STEEL SHAFTING.

SHALLOW-DRAFT RIVER BOATS—See RIVER BOATS. Also SHIPBUILDERS AND DRY DOCK COMPANIES.

SHEARING MACHINES, HYDRAULIC, STEAM POWER AND HAND.
Niles-Bement-Pond Co., New York.

SHEATHING METAL—See YELLOW METAL; also BRASS AND COPPER.

SHEETING, ASBESTOS.
Johns-Manville, H. W., Co., New York.

SHIPBUILDERS AND DRY DOCK COMPANIES—See also RIVER BOATS.
Bath Iron Works, Bath, Maine.
Fletcher, W. & A., Co., Hoboken, N. J.
Fore River Shipbuilding Co., Quincy, Mass.
Krajewski-Pesant Corporation, Havana, Cuba.
Marine Iron Works, Chicago, Ill.
Marvel, T. S., Shipbuilding Co., Newburg, N. Y.
Merrill-Stevens Co., Jacksonville, Fla.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Seattle Construction & Dry Dock Co., Seattle, Wash.
Tietjen & Lang Dry Dock Co., Hoboken, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.

SHIP CHANDLERS—See CHANDLERY STORES.

SHIP ELEVATORS—See MARINE ELEVATORS.

SHIP FITTINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Griscom-Russell Co., New York.

SHIP GLUE—See MARINE GLUE.

SHIP LOGS AND SPEED INDICATORS.
Schuette Recording Compass Co., Manitowoc, Wis.

SHIP STORES—See CHANDLERY STORES.

SHIPYARDS—See SHIPBUILDERS.

SHOWER BATHS—See PLUMBING.

SLOTTING MACHINES.
Niles-Bement-Pond Co., New York.

SMOOTH-ON.
Smooth-On Mfg. Co., Jersey City, N. J.

SOOT BLOWERS.
Diamond Power Specialty Co., Detroit, Mich.

SPEED INDICATORS FOR SHIPS, YACHTS AND MOTOR BOATS.
Schuette Recording Compass Co., Manitowoc, Wis.

SPRINGS, VANADIUM.
American Vanadium Co., Pittsburg, Pa.

STEAM ACETYLENE LIGHTING SYSTEMS.
Milburn, Alex. C., Co., Baltimore, Md.

STEAM ENGINE INDICATORS—See INDICATORS.

STEAM ENGINES—See ENGINES.

STEAM GAUGES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Lytton Mfg. Corp., Franklin, Va.
McNab & Harlin Mfg. Co., New York.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

STEAM HAMMERS.
Niles-Bement-Pond Co., New York.

STEAM AND HOT-BLAST APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

STEAM PUMPS—See PUMPS.

STEAM SEPARATORS.
Griscom-Russell Co., New York.

STEAM SPECIALTIES.
Alberger Pump and Condenser Co., New York.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Diamond Power Specialty Co., Detroit, Mich.
Griscom-Russell Co., New York.

Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Lytton Mfg. Corp., Franklin, Va.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., New York.
Power Specialty Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Star Brass Mfg. Co., Boston, Mass.
Tillotson Humidifier Co., Providence, R. I.
Watertown Specialty Co., Watertown, N. Y.

STEAM SUPERHEATERS.
Babcock & Wilcox Co., New York.
Power Specialty Co., New York.

STEAM TRAPS.
American Blower Co., Detroit, Mich.
Griscom-Russell Co., New York.
Lytton Mfg. Corp., Franklin, Va.
National Tube Co., Pittsburg, Pa.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Tillotson Humidifier Co., Providence, R. I.

STEAM TURBINES.
Alberger Pump and Condenser Co., New York.
Bath Iron Works, Bath, Maine.
Bryant-Bery Steam Turbine Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
Fletcher, W. & A., Co., Hoboken, N. J.
Fore River Shipbuilding Co., Quincy, Mass.
General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Parsons Marine Steam Turbine Co., New York.
Terry Steam Turbine Co., Hartford, Conn.

STEAM TURBINE DYNAMOS.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.

STEAMERS, LIGHT-DRAFT, RIVER—See RIVER BOATS.

STEEL BALLS.
Bantam Anti-Friction Co., Bantam, Conn.

STEEL SHEET PILING.
Lackawanna Steel Co., Buffalo, N. Y.

STEEL VALVES—See FORGED STEEL VALVES.

STEEL, VANADIUM.
American Vanadium Co., Pittsburg, Pa.

STEERING GEARS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

STEERING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.

STEERING WHEELS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

STOP COCKS—See VALVES.

STOVES—See RANGES.

STRAIGHTENING ROLLS—See ROLLS.

SUB-MARINE PAINT.
Toch Bros. New York.

SUPERHEATERS—See STEAM SUPERHEATERS.

SUPERHEATER TUBES.
National Tube Co., Pittsburg, Pa.

SURFACE CONDENSERS—See CONDENSERS.

SWITCHBOARDS—See ELECTRICAL INSTRUMENTS.

TACKLE BLOCKS—See BLOCKS.

TANKS—COPPER, GALVANIZED IRON.
Griscom-Russell Co., New York.
Sands, A. B., & Son Co., New York.

TARPAULINS.
Wilford Cloth Co., New York.

TEAK—See LUMBER.

THERMOMETERS—FOR EVERY PURPOSE.
H. & M. Division of the Taylor Instrument Cos., Rochester, N. Y.

THREADING AND CUTTING MACHINES—See PIPE CUTTING AND THREADING MACHINES.

THROTTLE VALVES—See VALVES.

THRUST BEARINGS.
Bantam Anti-Friction Co., Bantam, Conn.

TILING—See INTERLOCKING RUBBER TILING.

TOILET ACCESSORIES.
Sands, A. B., & Son Co., New York.

TOOLS, MACHINE.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.

TOOLS, MACHINISTS' AND CARPENTERS—See BENCH TOOLS.

TOWING HOOKS AND CHOCKS.
American Engineering Co., Philadelphia, Pa.

TOWING MACHINES.
American Engineering Co., Philadelphia, Pa.

TRANSMISSION ROPE—See ROPE.

TRAPS—See STEAM TRAPS.

TUBES—See BOILER TUBES; also BRASS AND COPPER.

TUBE CLEANERS—See BOILER-FLUE CLEANERS.

TUBE CUTTERS—See BOILER TUBE CUTTERS.

TUGS—See SHIPBUILDERS.
TURBINES—See STEAM TURBINES.
TURNING ENGINES.
American Engineering Co., Philadelphia, Pa.
TURRET LATHES—See LATHES, TURRET.
TWINE—See ROPE—Also CORDAGE.
Columbian Rope Co., Auburn, N. Y.
Plymouth Cordage Co., North Plymouth, Mass.
TWIST DRILLS.
Morse Twist Drill & Machine Co., New Bedford, Mass.
UNIONS—See PIPE UNIONS.
VACUUM GAUGES—See STEAM GAUGES.
VACUUM TRAPS.
Griscom-Russell Co., New York.
Lytton Mfg. Corp., Franklin, Va.
VALVES—Also see RUBBER VALVES AND WATER VALVES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Griscom-Russell Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Lytton Mfg. Corp., Franklin, Va.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Power Specialty Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Star Brass Mfg. Co., Boston, Mass.
VALVES — BALANCED THROTTLE VALVES AND QUADRANT VALVES FOR SHIP ENGINES.
Schutte & Körting Co., Philadelphia, Pa.
VALVES, WATER.
Continental Iron Works, Brooklyn, N. Y.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
VANADIUM.
American Vanadium Co., Pittsburg, Pa.
VANADIUM STEEL.
American Vanadium Co., Pittsburg, Pa.
VARNISH—See PAINT.
VENTILATING FANS—See BLOWERS.
VENTILATORS.
Sands, A. B., & Son Co., New York.
VERTICAL PUMPS—See PUMPS.
VOLTMETERS—See ELECTRICAL INSTRUMENTS.
WATER CLOSETS—PUMP WATER CLOSETS—See PLUMBING.
WATER COLUMNS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jerguson Gage & Valve Co., Boston, Mass.
McNab & Harlin Mfg. Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Star Brass Mfg. Co., Boston, Mass.
Watertown Specialty Co., Watertown, N. Y.
WATER GAUGES AND ALARMS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Watertown Specialty Co., Watertown, N. Y.
WATERPROOF CANVAS—See CANVAS, WATERPROOF.
WATERPROOF LIQUID CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.
WATERPROOF LIQUID GLUE.
Ferdinand, L. W., & Co., Boston, Mass.
WATERPROOF PAINT.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Ferdinand, L. W., & Co., Boston, Mass.
WATERTUBE BOILERS—See BOILERS.
WATER VALVES—See VALVES, WATER.
WHARF DROPS.
American Engineering Co., Philadelphia, Pa.
WHISTLES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
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McNab & Harlin Mfg. Co., New York.
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YACHT GLUE—See MARINE GLUE.
YACHTS—See LAUNCHES AND YACHTS; also SHIPBUILDERS.

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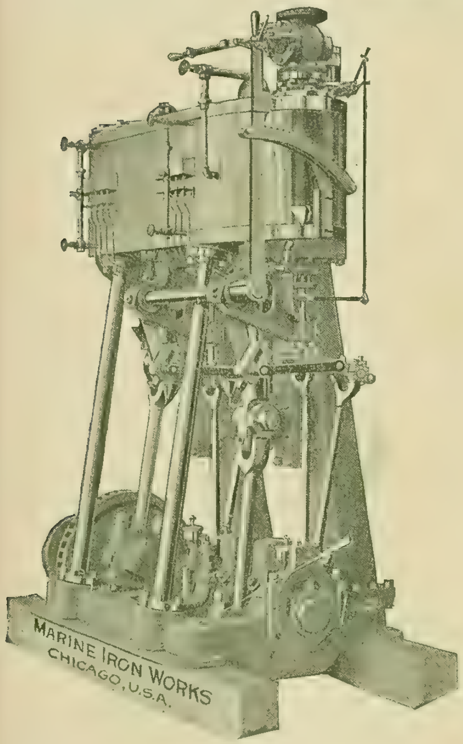
INTERNATIONAL MARINE ENGINEERING

NEW YORK, 17 Battery Place **LONDON, 31 Christopher Street, E. C.**

SUBSCRIPTION PRICE: Domestic, $2.00; Foreign, $2.50.



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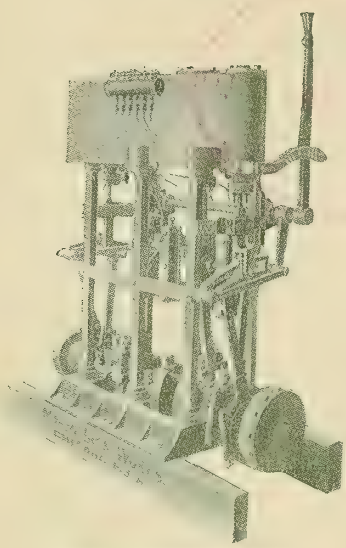

Open Column Frame
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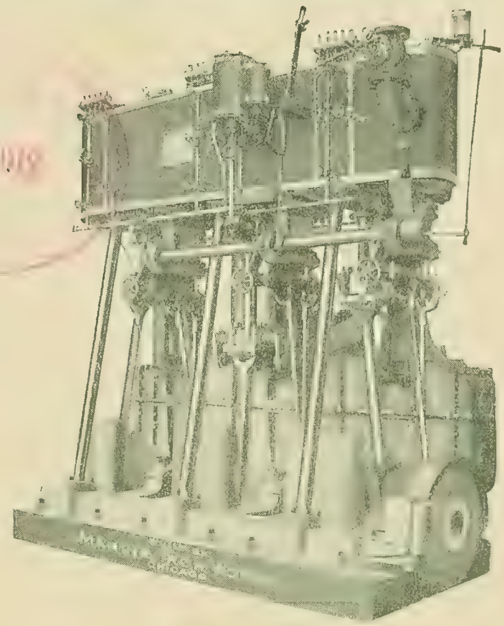
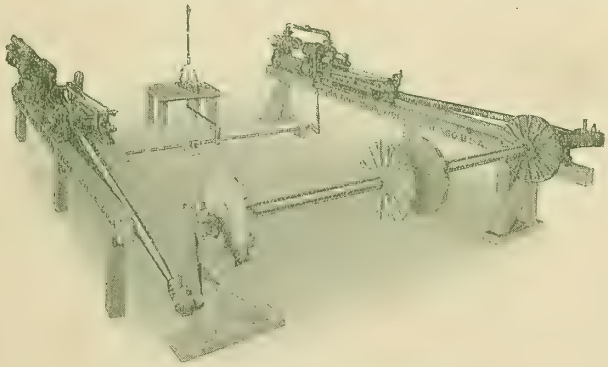


Triple Expansion

MARINE ENGINES



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Stern Paddle-Wheel Engines

MARINE IRON WORKS

CHICAGO, U. S. A.

Designers and Builders of Triple Expansion, Fore and Aft Compound, High Pressure and Stern Paddle-Wheel Machinery

Steel Framework and Complete Hulls for K.D. Shipment

International Marine Engineering

JANUARY, 1912

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CHRISTOPHER STREET
FINSBURY SQUARE, E. C.

NEW YORK:
WHITEHALL BUILDING
17 BATTERY PLACE

TRADE PUBLICATIONS.
AMERICA

"100 Buffalo Tales" is the title of a little book published by the Buffalo Gasolene Motor Company, 1209 Niagara street, Buffalo, N. Y. "In this little book we seek to repeat a few of the tales Buffalo users have told us concerning their engines. These statements are not edited. We simply reprint them as they were told to us, for the most part by men whom we have never seen, and who know us only by the work our engines are doing. Each one of the '100 Buffalo Tales' here told is a really-truly story. They were picked practically at random. There are several hundreds more just as good which we will be pleased to tell you, if you care to hear them. Possibly some of them are the words of your own neighbors, who will repeat to you what they have told us concerning Buffalo efficiency."

"Nonpareil High-Pressure Coverings" is the title of a handsomely printed cloth-bound volume of 72 pages, just issued by the Armstrong Cork Company, Pittsburg, Pa. So much has been written in recent years regarding the importance of insulating hot pipe lines, boiler breechings and other heated surface that it is hardly necessary to make extended reference to the subject here. In this, as in any other field, changed conditions require new methods and new materials, or at least the adaptation of old methods and materials to new conditions. Nonpareil high-pressure coverings are new, but not new in the sense of being untried, as they represent the result of years of research directed towards the improvement of the art of heat insulation. The claim is made in this book that, compared with coverings heretofore in general use, the Nonpareil coverings are more efficient non-conductors of heat; that they will withstand temperatures at which the older coverings will calcine and disintegrate: that they possess much greater moisture-resisting power; are just as easy to apply, and are equally reasonable in first cost. In this book is reproduced an extended report on the results of condensation experiments with Nonpareil high-pressure pipe covering, conducted by W. J. Baldwin, M. E., of New York City. The Armstrong Cork Company makes a long line of goods, including life preservers, buoys, yacht fenders, cork floor tiling, cork board for insulating cold-storage rooms, and other cork specialties of every description.

Robb-Brady Scotch boilers are described in Bulletin No. 3, published by the Robb Engineering Company, Ltd., South Framingham, Mass. The catalogue states that the circulation in these marine boilers is positive and rapid without a pump or other devices, and that the cost is reduced by using two small shells instead of one large one, and by eliminating the flat top combustion chamber and other expensive staying.

New outside spring calipers with patent rule attachment are among the great number of tools described in Catalogue 19-L issued by the L. S. Sterrett Company, Athol, Mass. These calipers are so made that zero will always come in line with one caliper point—there is only one easy reading to make. When folded back out of use the rule is held by a snap catch.

Wrenches of all kinds are described in a catalogue issued by J. H. Williams & Company, 63 Richards street, Brooklyn, N. Y. This company makes a special size pocket catalogue for marine engineers, and will send a copy to any of our readers upon application. "The abundant usefulness of the 'Big 6' set doesn't impress you until you are told of their extraordinary capacity. Seven most important bolt sizes (¼ to ¾ inch) and eight most important cap screw sizes (¼ to 1 inch) are in six wrenches. The handy canvas carrier-roll does the rest."

A very complete catalogue of brass and iron goods has just been published by the McNab & Harlin Manufacturing Company, 55 John street, New York. This is a profusely illustrated cloth-bound volume of 372 pages. "In presenting this, the eleventh edition of our illustrated catalogue to our customers and the trade, we invite attention to the change in style of some of the old patterns of valves etc., and to the increase in the variety of goods which we manufacture, notably: Extra heavy iron body globe and angle valves, outside screw and yoke iron body gate valve, indicator posts, iron body Jenkins disk valves, stop and check valves combined, oil country iron cocks, sea cocks, dye house swing joints, etc.; also to the fact that we have eliminated goods not of our manufacture which it has been our custom to illustrate in former editions, with the exception of malleable iron fittings and pipe. Steam pressures have increased, making it necessary to meet the new requirements. It has been our aim to keep fully in touch with the needs and demands of the trade, and we have adapted our patterns and machinery to meet this condition. We have endeavored to preserve the character of our goods by keeping them fully up to our well-known standards, believing that there will always be a legitimate demand for high-class standard goods, both in design and quality, sufficient to warrant the advanced price over competition goods, made necessary by the superior quality of the goods. We have increased our plant very materially and installed most modern machinery for turning out our product in the most improved manner and with the least possible delay; and we wish to emphasize the fact that we carry a large complete stock of all staple goods at our factory at Paterson, N. J., but 16 miles from New York, thus insuring prompt shipments of all orders."

Rockford planers are described in a catalogue just issued by Joseph T. Ryerson & Son, Chicago, Ill. "Modern methods of shop practice and the present extensive use of high-speed tool steels have caused an important era in the history of machine tools. Degrees of speeds and loads regarded as impossible a few years ago are now being used constantly, and to meet these changed conditions such machines must have extra power and be extremely rigid. Our planers are designed to meet all the conditions influencing modern shopwork and have every facility for high-speed production and accuracy of alignment. The difficulties of the planer problem are many. With machines having a continuous motion in one direction, the problem of speed is simply that of greater strength and necessary belt capacity. But with reciprocating machines, like planers, the problem is that of momentum, which depends directly upon the increased weight and velocity. A few years ago the capacity of carbon steels limited the speed of the forward or cutting stroke; the back or idle stroke being limited by nothing but this momentum, and could be increased to the full capacity of the mechanism to economically reverse. However, with the present use of high-speed steels the limit is only one of efficiency; that is, speed secured without waste of power, injury to mechanism of planer, or sacrificing the quality of the planer's work. Consequently, to-day, planer speed is not limited by cutting speed alone, nor by cutting and return speeds, but by the time taken in the full cycle in which a strong, steady forward stroke, swift, efficient return stroke, and ability to reverse promptly and smoothly are important elements. In producing this planer our aim has been to meet all these problems, and we have kept in mind the fact that weight and power, properly distributed and backed by good workmanship, are the factors that determine the efficiency of machines of this class."

A free copy of a catalogue illustrating and describing mattresses and cushions for yachts and vessels will be sent to all inquirers by Ostermoor & Company, 116 Elizabeth street, New York. The fact that these mattresses and cushions are as buoyant as cork, and are intended not only for comfort but also to be used in case of emergency for life-saving purposes, makes this catalogue of much interest to people connected with vessels of any kind.

Smooth-On Iron Cement No. 7 is described in a folder published by the Smooth-On Manufacturing Company, Jersey City, N. J. "The great value of Smooth-On is because of its peculiar chemical properties, namely, of metalizing and expanding when metalizing. These properties make Smooth-On a valuable substance in the making of chemical iron cements. To this subject the chemist of the Smooth-On Manufacturing Company has given careful study for eighteen years, and has succeeded in compounding the valuable iron cements known so generally throughout the world as Smooth-On Iron Cement. Smooth-On Iron Cement No. 7, the new Smooth-On product, has the same property as the other Smooth-On cements, of expanding when metalizing, and this makes it very valuable for use in connection with concrete and Portland cement, because, when applied to a crack in concrete or Portland cement the expanding action of the Smooth-On completely fills this crack."

A steam turbine for driving direct-current generators is described in pamphlet D-46, published by the De Laval Steam Turbine Company, Trenton, N. J. "This booklet explains the problem involved in selecting types of steam turbines; that is, the problem of reaching a compromise between the tremendous velocity of spouting steam and the comparatively moderate speeds demanded in the driven machinery, such as direct-current generators, centrifugal pumps and blowers, and for belt and rope driving. The pamphlet compares the several methods of compromise which have been adopted, such as pressure and velocity staging and combinations of the two, and describes a fourth method, which permits the turbine to be built with the number of stages best adapted for the capacity and to secure substantial and reliable construction, and to run at the speed most favorable for high efficiency, while the driven machinery may run at any speed required. This is the greatest advance in steam turbines made for many years, and you should be familiar with it."

Flanged gaskets are described in the latest number of the "J-M Packing Expert," issued by the H. W. Johns-Manville Company, 100 William street, New York. "J-M Permanite gaskets are cut from J-M Permanite sheet packing No. 60. They make permanently tight joints that require no following up, successfully pack surfaces where even copper gaskets have failed, and consequently enjoy well-deserved popularity in scores of the largest power plants where they are giving unsurpassed satisfaction under any and all conditions. The high heat and chemical resisting qualities of J-M Permanite flange gaskets are due to the fact that they are cut from J-M Permanite sheet, which latter is made from the highest obtainable quality of long-fiber asbestos. By an exclusive formula, entirely our own, certain compounds are combined with the asbestos which make the resultant packing highly resilient and extremely pliable. Asbestos is a practically indestructible material, hence J-M Permanite flange gaskets resist highest temperatures and pressures, withstand the action of fluids and chemicals, never burn or blow out, and do not stick to the flanges."

Conoidal fans are described in Catalogue No. 190, published by the Buffalo Forge Company, Buffalo, N. Y. "The Buffalo "Conoidal" fan derives its name from the prevalence of conical shapes in its design. The inlet is conical; the blast wheel forms the frustum of a cone, and the blades are curved over the tapering surface of a cone. Although it is a comparatively short time since this fan was put on the market by us in its present perfected shape, its superiority over older types has already been clearly demonstrated. Three great advantages combine to place it ahead of all others: First, the design itself, which, as will be seen from the following pages, is essential to the highest efficiency. Secondly, the great structural strength and rigidity to which this design so readly lends itself. And last, but not least, its correct proportions, in which we have come nearer perfection than any other manufacturer. Our claims of superiority for these fans are based, not only on tests made by ourselves, but upon competitive trials conducted by competent engineers exclusively in the interest of firms employing them, who have chosen from the best that the market affords and picked from among these the 'Conoidal' fan for their own use, as the one type which shows the greatest advantages in efficiency, strength and reliability."

TRADE PUBLICATIONS

GREAT BRITAIN

"A patent inclosed engine for power, traction and lighting" is the subject of a catalogue just published by W. Sisson & Company, Gloucester. This engine is double-acting, self-lubricating, silent running, has large overload capacity, automatic expansion governing, low steam consumption.

Dobbie McInness, Ltd., 57 Bothwell street, Glasgow, have issued circulars of their various marine specialties, among which they specially call attention to their McInness-Dobbie patent indicators for steam and gas engine work, of which you will further observe we have several forms for continuous and similar purposes. Also, McInness-Dobbie improved Bourlon gages, Messenger's furnace deformation indicator, Clyde furnace indicator, Hopkinson flashlight indicator, Sellers portable dynamometer, etc., etc. "A booklet for which there is quite a demand is our 'Commercial Value of Indicator Diagrams.'"

Heath & Company, Ltd., Crayford, London, are anxious to send shipowners a special catalogue dealing with their latest patented standard binnacles. The list shows binnacles suitable for every type of vessel from the largest to the smallest, and embraces all the improvements to date; also sounding machines which are made to the Kew standard. A glance through their lists will prove of great service when drawing up specifications for new ships or replacements. To insure getting first-class instruments on board specify that they must be made by this firm, as all their "Hezzanith" instruments are guaranteed. Application should be made at once for this useful book of reference. The firm issues seven large catalogues: No. 1, Sextants; No. 2, Binnacles and Compasses; No. 3, Barometers and Clocks; No. 4, Logs, Sounding Machines, Lamps, etc.; No. 5, Thermometers and Thermographs; No. 6, Surveying Instruments; No. 7, Mathematical Instruments and Sundries. Heath & Company, Ltd., have been established at Crayford, London, since 1846, and are contractors to many of the governments.

Steel sheets, black and galvanized, plain and corrugated, are the subject of a pamphlet published by the Bowesfield Steel Company, Ltd., 110 Cannon street, London, E. C.

Watertube boilers, accessories and automatic stokers are described in a handsomely illustrated catalogue of 28 pages published by the British Niclausse Boiler Company, Ltd., Caxton House, Tothill street, Westminster, S. W. The Niclausse boiler is a watertube boiler of the large tube type, and has been in successful operation, both for marine and land purposes, for the past twenty years. Over 3,000,000 horsepower are now in use, which have been supplied to British, French and other gocernments.

Pickerings, Ltd., Globe Elevator Works, Stockton-on-Tees, have published an excellent catalogue of pulley blocks, chain hoists, overhead runways, friction hoists, winches, goods and passenger lifts, cranes and other lifting appliances, illustrated, prices and other particulars of which are given in most cases. The list also states prices of shafting, plummer blocks, pulleys, machine molded gears and Pickering governors. In order to ensure the safe working of lifts, cranes and other machinery, Messrs. Pickerings employ a staff of experienced men periodically to inspect and report on such machinery.

A catalogue of steam-proof flare lamps, hand-lamps, etc., is published by Imperial Light, Ltd., 123 Victoria street, London, S. W. "The introduction of Imperial lights has revolutionized the lighting of open spaces. These lights are more handy, efficient and economical than any other form of flare, and no one who is dependent from time to time upon portable lights can possibly afford to be without them. We are now supplying Imperial lights to every country in the world. They have been subject to the severest tests under every conceivable condition, and the general opinion of our thousands of customers is that Imperial lights are without exception the very best for the purposes for which they are designed. During the last few years the sales of Imperial lights have increased beyond our most sanguine anticipations, and our success is entirely due to the simplicity and efficiency of design, coupled with the economy in initial cost and maintenance. Imperial acetylene flare lights and hand-lamps, which are fully protected by British and foreign patents, are dealth with in detail in this catalogue, and the illustrations are from photographs of actual lights of each type."

Ship Draftsmen Required.—Capable, neat and thoroughly

BUSINESS NOTES

AMERICA

THE ROBB ENGINEERING COMPANY, LTD., South Framingham, Mass., reports recent sales of horizontal return-tube boilers as follows: Charles A. Luddin, Chicopee, Mass.; four to McLean & Cousens, Boston, Mass.; Adams Bros., Pittsfield, Mass.; J. P. McDonald, Woburn, Mass.; Brown & Simmonds, Somerville, Mass.

THE NEW YORK National Motor Boat Show for 1912 will be held in the 69th Regiment Armory, on 25th and 26th streets, New York City, from Feb. 17 to 24, inclusive. On account of the sale of the Madison Square Garden the National Association of Engine and Boat Manufacturers has been obliged to look elsewhere for an exhibition hall. The association states that it has found the armory to be well suited for the purpose, and that it affords 25 percent greater area than the space formerly used in the Madison Square Garden.

THE KERR TURBINE COMPANY, Wellsville, N. Y., states that over 700 of its machines, aggregating more than 50,000 horsepower, are in active service, and that more unfilled orders are now booked than at any previous time in the history of the company. Although the plant has been materially enlarged, a night shift has been necessary for the past two and a half years. Among recent orders are the following: Two 75-kilowatt and one 35-kilowatt lighting sets to American Shipbuilding Company for the new steamer *City of Detroit;* one 350-kilowatt turbo-alternator for the Brooklyn refinery of the Standard Oil Company; two 2,800-gallon per minute turbo-pump units for Tidewater Oil Company; two 75-kilowatt lighting sets for water-works service, city of Chicago; one 60 brake-horsepower turbo-generator with Prony brake attachment for the University of Melbourne, Australia (this unit takes steam at 200 pounds gage, with 200 degrees superheat, and exhausts to 28 inches vacuum); one 215-horsepower turbo-blower for People's Gas Light & Coke Company, Chicago (the tenth set of this size ordered by these people); two underwriter fire pumps driven by 200-horsepower Kerr turbines, for Stieger & Sons piano factory, Stieger, Ill.; one fire pump, driven by 265-horsepower Kerr turbine, for B. M. Osbun Company, Chicago. This last-named will be the only turbine-driven fire pump in the city of Chicago.

BOILERS OF THE STEAMSHIP *Melrose,* of the New England Coal & Coke Company, Boston, Mass., have been equipped with the Ross-Schofield system of circulation. This is the first of three vessels owned by this company for which this system, manufactured by the Ross Schofield Company, 39 Cortlandt street, New York, has been ordered.

C. G. Cox, formerly connected with the General Electric Company, has become sales manager of the Busch-Sulzer Bros.—Diesel Engine Company, with headquarters at the general sales offices, South Side Bank building, St. Louis, Mo. Mr. Cox will devote himself to the marine type as well as to the stationary engines of this company.

R. SANFORD RILEY, of Providence, R. I., who as president of the American Ship Windlass Company developed the Taylor stoker, has sold out his interest there and organized the Sanford Riley Stoker Company to exploit a new self-cleaning underfeed stoker.

SIROCCO FANS, built by the American Blower Company, Detroit, Mich., have been installed on a large number of ships recently built by the Great Lakes Engineering Works, Detroit, Mich. The car ferry *Chief Wawatam,* belonging to the Mackinac Transportation Company, and built by the Toledo Shipbuilding Company, is equipped with two Sirocco fans. The *City of Detroit III.*, now under way at the yards of the Detroit Shipbuilding Company, is fitted with three forced draft Sirocco fans with Type E. engines. "Some idea of the extent of our marine business can be gained from the fact that we have something over 320 Type 'A' and 'E' engines installed on boats. Our records in this connection are not entirely complete, as it is impossible to trace the destination of apparatus in every instance. We have, however, record of 132 engines supplied for direct connection to generators, 146 for operating mechanical draft apparatus and 45 for miscellaneous uses—such as driving refrigerating machines, operating ash hoists, etc. Of these, 218 are installed on boats operating on the Great Lakes, 35 on ocean-going vessels or those operating along the coasts, and 70 on boats on rivers, canals, etc. This latter item includes 20 engines furnished for dredges on the Isthmus of Panama."

BUSINESS NOTES

GREAT BRITAIN

LEITH DOCK COMMISSIONERS have placed contracts for harbor equipment which include an hydraulic swing bridge from Armstrong, Whitworth & Company, and a crane of 110 tons capacity from Cowans, Sheldon & Company. The crane will be capable of lifting to a height of about 80 feet above water level, and will project 42 feet from the face of the quay. The crane itself will cost £8,000, and the foundations and sidings about £2,800.

RECENTLY some new plant, says *The Times,* has been erected at the electrical engineering laboratories of the Liverpool University, with the object of facilitating tests on certain types of electrical machinery, and the new Harrison-Hughes engineering laboratories, which are an addition to the University equipment, are being supplied with plant for experimenting in marine engineering, in which special attention is devoted to the economic aspect of liquid fuel. The electrical laboratories have been equipped with a complete installation of apparatus for the purpose of wireless telegraphy, the gift of Sir W. P. Hartley. A complete set of receiving and transmitting appliances is provided to afford direct communication with the Eiffel Tower and the North of Germany. At present the University is in touch with vessels within a radius of 50 miles. The installation is a full-scale one, similar to those used for commercial purposes, but it will be applied solely to the teaching of students and to research and experiment. The feature of the Harrison-Hughes engineering laboratories is the provision for internal-combustion engines. The department has recently been equipped with a 50-horsepower Diesel engine and a 25-horsepower Blackstone engine, both of which consume crude oil, and are of the type that is beginning to be employed for the propulsion of ships. A suction gas-producer of 60 horsepower for bituminous fuel is being installed for use in conjunction with a gas engine, both of which have been constructed by Crossley Bros. Provision is also made for research in mining engineering, and particularly in connection with the transmission of power underground. In this connection a powerful air-compressing plant will be provided.

WE LEARN from the Pulsometer Engineering Company, Ltd., of Reading, that they have received a diploma of honor and a gold medal for their "Geryk" vacuum pumps, shown at the International Exhibition at Turin. The diploma of honor is the second highest award, being only surpassed by the grand prix.

THE WELL-KNOWN FIRM of Joseph Kaye & Sons, Ltd., South Accommodation Road, Leeds, and 93 High Holborn, London, W. C., have again secured the whole of the contract for the supply and delivery of their patent seamless serrated oil cans to H. M. naval establishments for the next three years ending 1914, fitted with their latest patent thumb button (Patent No. 2775, Feb. 3, 1911), and, as previously announced, this invention dispenses with the thumb button being soldered to the valve spindle, which is considered to be a great improvement, as it is claimed to be impossible to detach the new thumb button and leave only the bare end of the valve spindle for the thumb to press against, as hitherto. Messrs. Kaye have supplied 44,000 of their patent serrated oil cans to previous contracts for H. M. navy, but this is the first contract under the new patent.

PROBABLY THE MOST INTERESTING example of oil-driven vessels is *Jutlandia,* which was built recently by Barclay Carle & Company, Whiteinch. This twin-screw vessel was built to the order of the East Asiatic Company, of Copenhagen, and is 384 feet in length, 53 feet 3 inches in breadth, 30 feet in depth, 23 feet 6 inches in draft, of 10,000 tons displacement, 7,000 tons deadweight, and 5,000 tons gross. She will be supplied by the builders with two sets of Diesel oil engines, capable of developing 3,000 indicated horsepower. She will have three masts, and the fumes from the engine room will be led up inside the mizzenmast and exhausted at a height of 48 feet above the deck, so that a funnel is not required even for exhaust purposes. The siren, on the mainmast, will be operated by compressed air. Perhaps the most noticeable feature of the design is that the machinery space is only about a third of that which would have been necessary for steam engines, and that the absence of boilers and boiler casings leaves a large amount of hold space for the storage of cargo, and far more deck space for the use of passengers than would be possible if the vessel were fitted with steam engines. It is expected that the *Jutlandia* will run trials next month.

A new surveying vessel, designed by Gray & Brace, naval architects, of London, embodies some interesting and novel features. The ship is a little over 200 feet long. She is rigged as a four-masted schooner, and auxiliary power is provided by a gas engine situated aft. The producers and scrubbers are close to the engine, in large, well-ventilated spaces. Anthracite coal is to be used. The accommodation for the staff of surveyors includes a number of large cabins. The ship is lighted by means of electricity, and is ventilated on the well-known thermo-tank system. The nature of the surveying which the vessel will do has not been disclosed, but part of the vessel's equipment is a complete trawling gear similar to that used by the largest Grimsby trawlers.

The turbine erecting shops which have been added to the engineering works at Stobcross of the London & Glasgow Shipbuilding & Engineering Company are, says the *Glasgow Herald,* well equipped with turning, planing and other machine tools required for heavy Admiralty work. Three new overhead, three-motor electric cranes have been installed recently. These cranes are each of 60 tons capacity, and have been subjected to test loads of 72 tons. Two of them, in the turbine erecting shop, are of 47 feet span, and the third, in the machine shop, is of 42 feet 6 inches span. The height to crane rails from the floor of the shops is 49 feet. The shops themselves are 300 feet in length. The operations of lifting, cross-travel and long-travel are effected at speeds which indicate the high efficiency of the equipment. The full load of 60 tons is lifted at a speed of 5 feet per minute, and a load of 25 tons is lifted at a speed of 11 feet 6 inches per minute; while for lighter loads the lift speed is from 12 feet to 15 feet per minute. The speed of cross-travel is 60 feet to 90 feet per minute, and of long-travel 200 feet to 240 feet per minute. The hoisting motor is of 33½ brake-horsepower and 450 revolutions per minute. The cross-travel motor is of 10 brake-horsepower, and 475 revolutions per minute, while the long-travel motor is of 275 brake-horsepower and 450 revolutions per minute, all wound for an electromotive force of 500 volts continuous current. The controllers are of the reversing tramway type, with regulating metallic resistances and hand levers. A powerful automatic electric brake is fitted to the motor spindle, and there is also a mechanical brake fitted to the second motion shaft, working from the cage by foot lever. The hoisting controller is arranged on the lowering side, with five-brake contacts, so that on these positions the motor is short circuited from the main, and works as a generator through resistance, thus preventing the load from accelerating and causing damage to the armature. The crab is built of mild steel plates and angles, and has mild steel shafts for the different motions, running in adjustable bearings, bushed with gunmetal, the whole being mounted on four double-flange mild steel rail wheels, 18 inches in diameter. The hoisting, as well as the cross and long-travel gear, is all of steel and machine-cut from solid metal. The main structures of the cranes, consisting of cross girders and end carriages, are built, box-section, of mild steel plates and angles, the girders being 4 feet 1 inch deep at the center of the span. The end carriages are each fitted with two rail wheels, 3 feet in diameter, having centers of cast iron, with double-flanged steel tires shrunk on. The axles are of steel, and run in cast iron bearings, spigoted and bolted to the webs of the carriages. The bearings are bushed with gunmetal, and are of the self-oiling type. The lifting tackle consists of eight falls of special steel wire rope.

LANCASTER & TONGE, LTD., Pendleton, Manchester, have, we understand, received an order from the Commonwealth Portland Cement Co., Sydney, New South Wales, for four M. S. piston rods, two 24⅜-inch C. I. junk cover pistons complete with rings and coil, two 45⅜-inch C. I. junk cover pistons complete with rings and coil, two sets 5⅜-inch duplex metallic packings, two sets 4⅛-inch duplex metallic packings, two sets 5⅜-inch single metallic packings, two sets 4⅛-inch single metallic packings, two sets 24⅜-inch piston rings and serpent coils as spares, two sets 45⅜-inch piston rings and serpent coil as spares, eight sets spare parts complete for metallic packings (one set each).

ENGINES OF NEW ALLAN LINERS.—In the two steamers which are being built at Fairfield and Dalmuir, respectively, for the Allan Line, says *Engineering*, the Frahm anti-rolling tank system will be adopted. There will be four screw shafts arranged in three engine rooms, and the shafts will be driven by turbines of the Parsons type, consisting of one high-pressure ahead, one intermediate-pressure ahead, and two low-pressure ahead turbines, and two astern turbines. The two astern turbines will be incorporated with the low-pressure ahead turbines, and will be on the inner lines of shafting. The power will be divided as nearly as possible over the four shafts, and each shaft will be fitted to work independent of the others by a suitable arrangement of pipes and valves. The total power is to be 19,000 shaft-horsepower. The boilers are to be worked under Howden's forced draft, and they will be arranged so that oil fuel may be used, if it is found economically possible to do so. There will be six double-ended and four single-ended boilers, the former being 16 feet 9 inches in diameter by 22 feet long. For the carriage of provisions refrigerating machinery and cold stores with a capacity of 70,000 cubic feet are arranged for. It will thus be recognized, it is added, that the two ships, which are to be classed under the British Corporation for the Survey and Registry of Shipping, promise to be thoroughly adapted for the Canadian service, alike in speed, comfort and cargo capacity.

IN CONNECTION with this year's Cutlers' Feast at Sheffield, Cammell Laird & Company, Ltd., issued an extremely well-got out brochure which includes photographs and a short description of their works. The guests of the Master Cutler paid an interesting visit to these works. The Cyclops Works, where the head offices of the company are situate, cover an area of 11 acres, and are intersected by the Midland Railway Company. The company has the advantage of its own private sidings. A large portion of these works is confined to the treatment and finishing of armor plates, for which purposes the department is provided with specially designed furnaces, oil tanks, douches, hydraulic presses and other appliances. There are also nine machine shops, where the plates are machined and ground. This department is capable of producing annually up to 15,000 tons of finished armor of the latest type, ranging from 2 inches up to the thickest plate demanded by naval contractors. The remaining portion of the Cyclops Works is confined to the manufacture of railway axles and general forgings, crucible and special high-speed tool steels and files and rasps, also nickel steel, deck and bullet-proof plating for all kinds of war vessels and for artillery and other purposes. The average annual outputs (other than armor) are 8,000 tons of nickel-steel plates and deck plates, 15,000 tons of axles and forgings, 1,500 tons of crucible steel, and 125,000 dozen files and rasps. As in the case of Cyclops Works the Grimesthorpe Works adjoin the Midland Railway Company's line. These works cover 26 acres, and embrace the manufacture of Siemens-Martin steel on the open-hearth principle for all purposes. At these works the whole of the steel is produced for the manufacture of armor and general purposes. The other departments at Grimesthorpe may be briefly enumerated as follows: Steel foundry, for the manufacture of ship and general castings of the heaviest class for engineering purposes, also mining castings. Press shops, for the manufacture of gun and other forgings of all descriptions. Machine shop for finishing castings, forgings and other materials produced. Two tire plants for the manufacture of engine, carriage and wagon tires, and angle-rings for boiler purposes. Armor plate rolling department. Spring department, where the manufacture of all classes of railway and other springs is carried on. Projectile department and iron foundry. The annual output of the Grimesthorpe Works is approximately 100,000 tons of steel ingots for armor and other uses, and for the general purposes of the engineering industry, and 10,000 tons of steel castings. From the steel produced the company has an approximate annual output of 10,000 tons of gun and other forgings, 15,000 tons each of tires, buffers and springs, and over 100,000 projectiles of various types.

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Twenty-four thousand pounds has been apportioned by the Italian government for dredging the entrance channel at Marsala to a depth of 6 meters, and for dredging a zone 300 meters long and 150 meters wide in the east basin to a depth of 5.5 meters. A contract for lengthening the mole by 165 meters on the west side of the harbor has been let at a cost of £40,000, and it is expected that the work will occupy four years.

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Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

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The largest sea-going motor boat under the Belgian flag has recently been constructed at Amsterdam to the order of the Société Anonyme d'Armement, d'Industries et de Commerce for the conveyance of oil in bulk. She has a length of 395 feet, a width of 53 feet and a depth of 29 feet, and has been fitted with two motors capable of developing 1,100 horsepower each.

We understand that Messrs. Richardsons, of Billiter Square buildings, London, E. C., have just been appointed London representatives of Messrs. Tait & Company, Kobe, Japan, who are opening an engineering department. Firms desirous of finding a market for their manufactures in Japan and the East should send their catalogues in duplicate to Messrs. Richardsons' export department.

S. T. Taylor & Sons, of Scotswood-on-Tyne, covered the boilers of the steamship *Sir Robert Coverdale* and the steamship *Roselands* with their "Tynos" non-conducting composition. They also have covered the boilers and steam pipes of the steamship *Japanese Prince* with their "Tynos" non-conducting composition, and the boiler bottoms with their "Tynos" patent mattresses.

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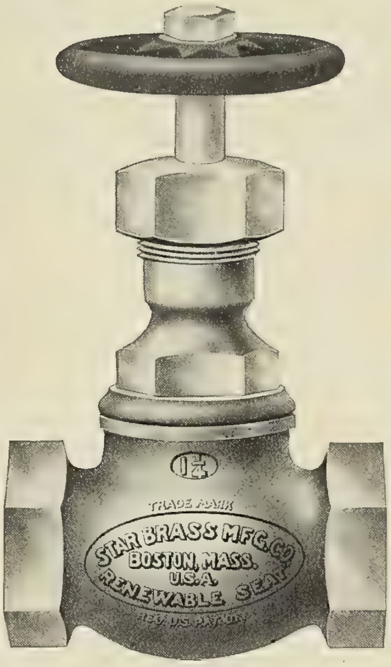

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Seat rings are of a "Patented" form with special taper seat where screwed in body. This design insures a perfect joint and absence of liability to distortion from lack of care in installation or unequal expansion in use.

The bonnet is novel in design, having many unique features. First, it is absolutely self-draining, thereby eliminating all liability to freeze when used in cold positions; has extra large and deep packing space, gland and nut. Long thread in body, insuring strength and tightness.

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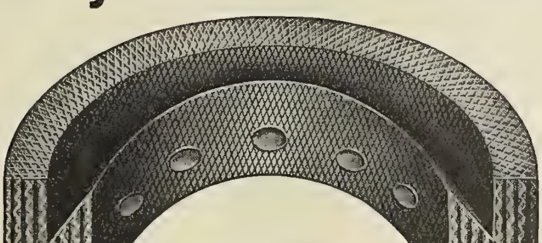

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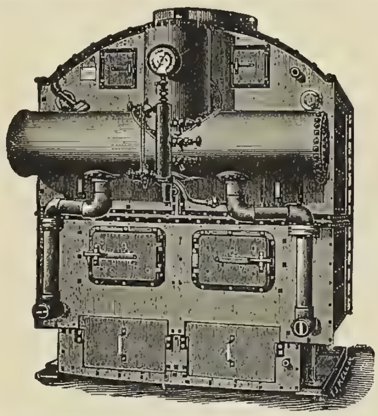

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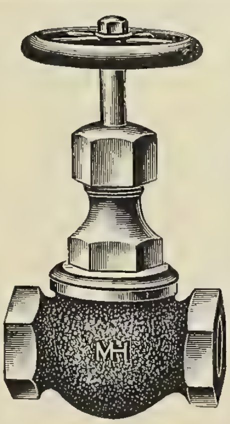

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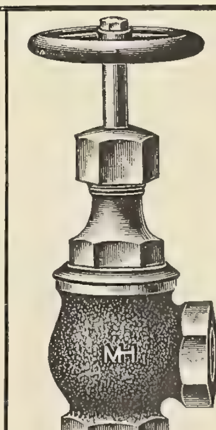

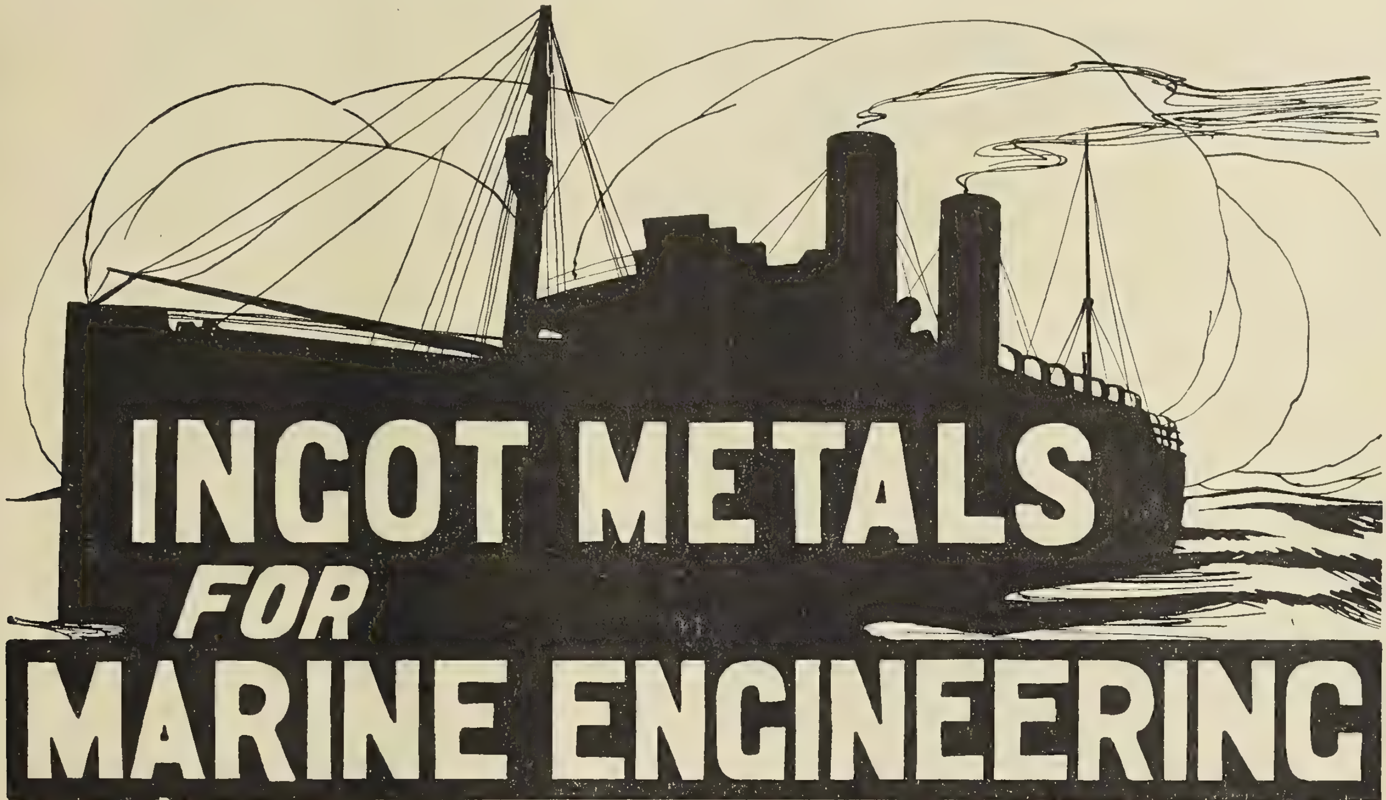
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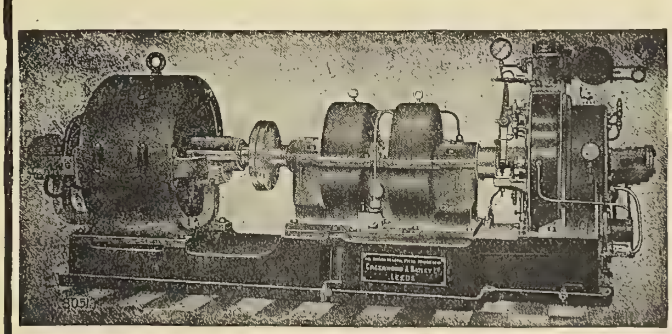

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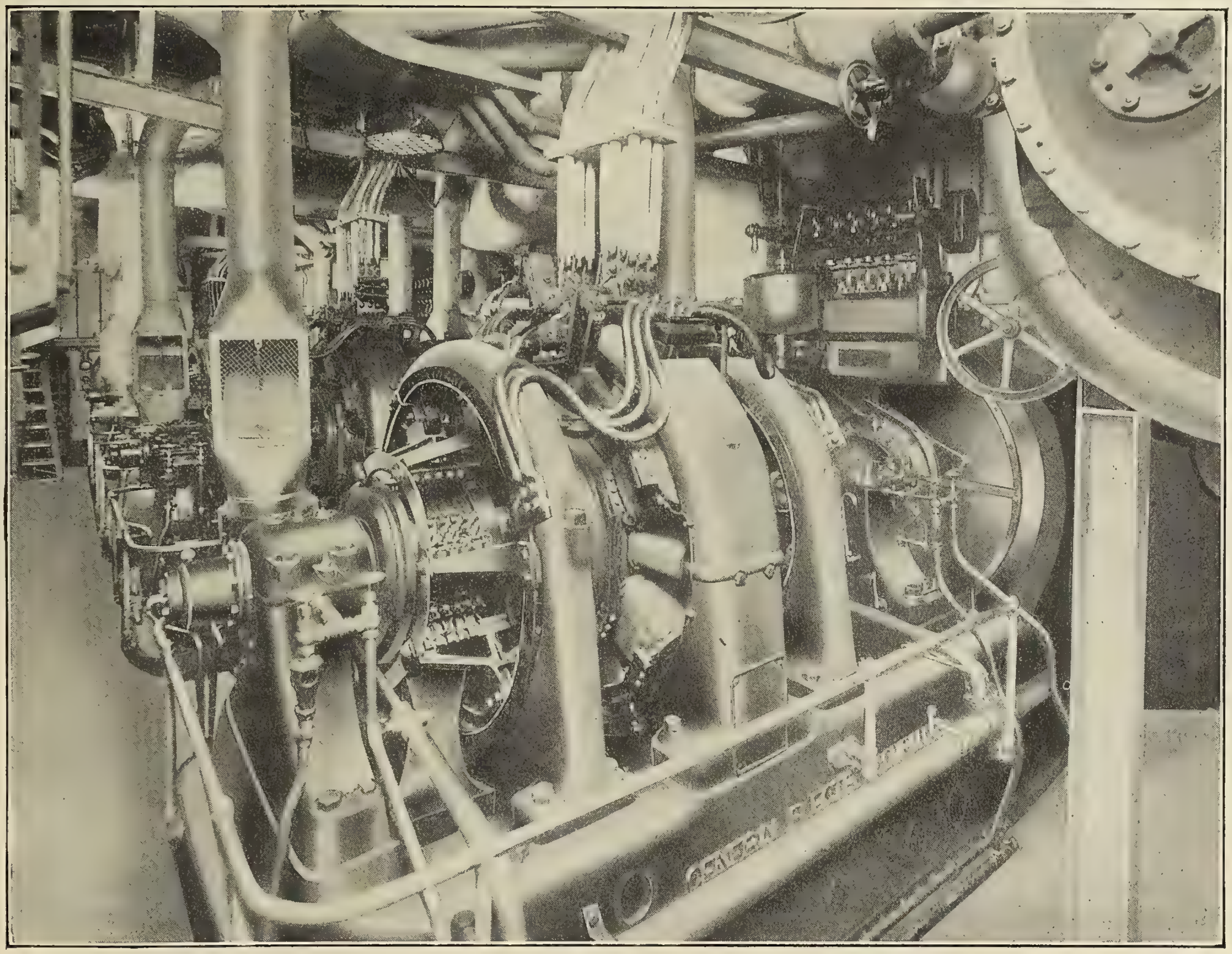

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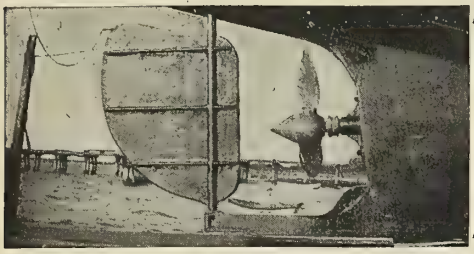

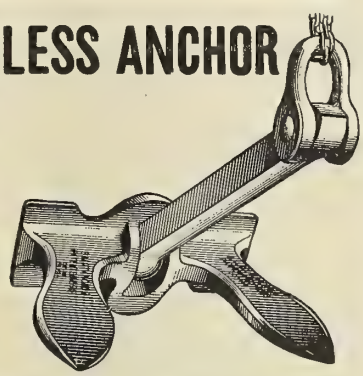

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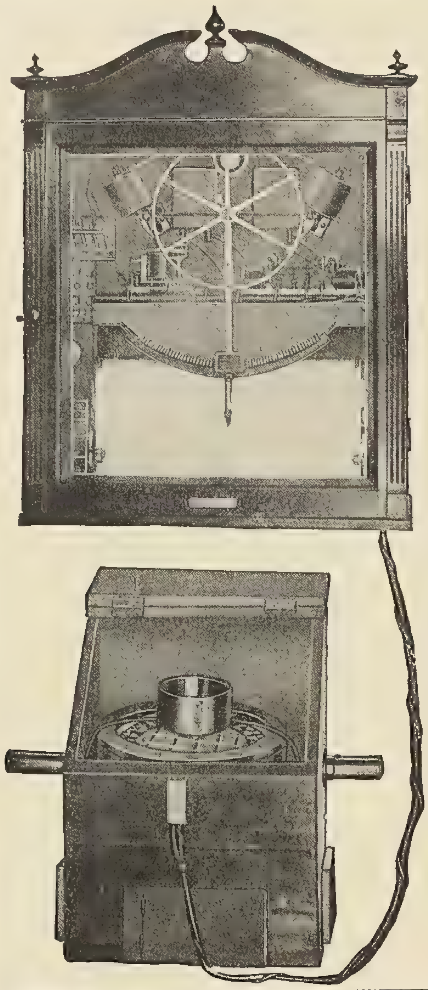

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ANTI-RUST COATINGS.
Ferdinand, L. W., & Co., Boston, Mass.

APPARATUS (MARINE GLUE MELTING).
Ferdinand, L. W., & Co., Boston, Mass.

ASBESTOS—See NON-CONDUCTING COVERING; also see PACKING, ASBESTOS.

ASBESTOS PACKING—See PACKING, ASBESTOS.

ASH HOISTS.
Davidson, M. T., Co., New York.
Hyde Windlass Co., Bath, Maine.
Williamson Bros. Co., Philadelphia, Pa.

ATTORNEYS—PATENT.
Decker, Delbert H., Washington, D. C.

AUTOMATIC INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.

AUTOMATIC TOWING MACHINES—See TOWING MACHINES.

AUTOMATIC WATER GAUGES—See WATER GAUGES.

BABBITT METAL—See ANTI-FRICTION METAL.

BALL BEARINGS—See THRUST BEARINGS.

BARGES—See SHIPBUILDERS.

BATH TUBS—ENAMELED IRON, PORCELAIN.
Sands, A. B., & Son Co., New York.

BEARINGS—See ANTI-FRICTION METAL; also THRUST BEARINGS.

BELLS.
Hayward, S. F., & Co., New York.
National Tube Co., Pittsburg, Pa.
Vanadium Metals Company, Pittsburg, Pa.

BELTING—See RUBBER BELTING.

BENCH TOOLS.
Billings & Spencer Co., Hartford, Conn.
Pratt & Whitney Co., New York.
Starrett, L. S., Co., Athol, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

BENDING MACHINES, KEEL PLATE OR GARBOARD.
Niles-Bement-Pond Co., New York.

BENDING ROLLS—See ROLLS.

BILGE PUMPS—See PUMPS.

BITTS.
American Ship Windlass Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

BLACK PRINT PAPER.
Frey, Louis, & Co., New York.

BLOWERS.
American Blower Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Sirocco Engineering Co.—See American Blower Co.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

BLOW-OFF VALVES—See VALVES.

BLOWERS, SOOT—See SOOT BLOWERS.

BOAT ACCESSORIES.
Ferdinand, L. W., & Co., Boston, Mass.
International Acheson Graphite Co., Niagara Falls, N. Y.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N.Y.

BOAT BUILDERS—See LAUNCHES AND YACHTS.

BOAT DAVITS—See DAVITS.

BOAT FITTINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Ruggles-Coles Engineering Co., New York.
Vanadium Metals Company, Pittsburg, Pa.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N. Y.

BOATS—See LIFE BOATS; also LAUNCHES AND YACHTS.

BOILERS—Also see ENGINE BUILDERS—also SHIP BUILDERS.
Almy Water Tube Boiler Co., Providence, R. I.
Babcock & Wilcox Co., New York.
Bath Iron Works, Bath, Maine.
Griscom-Spencer Co., New York.
Hyde Windlass Co., Bath, Maine.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Mosher Water Tube Boiler Co., New York.
Robb Engineering Co., South Framingham, Mass.
Roberts Safety Water Tube Boiler Co., Red Bank, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.

BOILER CIRCULATORS.
Ross Schofield Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

BOILER COMPOUNDS.
Johns-Manville, H. W., Co., New York.

BOILER COVERING—See NON-CONDUCTING COVERING.

BOILER FEEDERS—See FEED-WATER REGULATORS.

BOILER-FLUE AND TUBE CLEANERS.
Griscom-Spencer Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

BOILER FLUE AND TUBE CUTTERS.
Faessler, J., Mfg. Co., Moberly, Mo.
Griscom-Spencer Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

BOILER FLUE AND TUBE EXPANDERS.
Faessler, J., Mfg. Co., Moberly, Mo.

BOILER AND PIPE COVERINGS—See NON-CONDUCTING COVERING.

BOILER RIVETS—Also see RIVETS.
Champion Rivet Co., Cleveland, Ohio.

BOILER ROOM FITTINGS.
American Blower Co., Detroit, Mich.
American Steam Gauge & Valve-Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Griscom-Spencer Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Star Brass Mfg. Co., Boston, Mass.

BOILER STAYBOLTS—See STAYBOLTS.

BOILER TUBES.
National Tube Co., Pittsburg, Pa.

BOILER TUBE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

BOILER TUBE RETARDERS.
Griscom-Spencer Co., New York.

BOLTS AND NUTS.
National Tube Co., Pittsburg, Pa.

BOOKS.
Van Nostrand Co., D., New York.

BORING BARS—See CYLINDER BORING BARS.

BORING MACHINES—METAL WORKING.
Niles-Bement-Pond Co., New York.

BORING MACHINES—WOOD.
Independent Pneumatic Tool Co., Chicago and New York.

BORING AND TURNING MILLS.
Niles-Bement-Pond Co., New York.

BRASS AND COPPER—Also see YELLOW METAL; also MUNTZ METAL.
Ruggles-Coles Engineering Co., New York.
Vanadium Metals Company, Pittsburg, Pa.

BRASS CASTINGS.
Griscom-Spencer Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Vanadium Metals Company, Pittsburg, Pa.

BRASS FITTINGS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell Co., Wm., Cincinnati, Ohio.
Ruggles-Coles Engineering Co., New York.
Star Brass Mfg. Co., Boston, Mass.

BRAZING MATERIALS.
Smooth-On Mfg. Co., Jersey City, N. J.

BRONZE.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.
Ruggles-Coles Engineering Co., New York.

BRONZE CASTINGS—See CASTINGS, BRONZE.

BRONZE-VANADIUM.
American Vanadium Co., Pittsburg, Pa.
Vanadium Metals Co., Pittsburg, Pa.

BUOYS.
American Gasaccumulator Co., Philadelphia, Pa.
Sands, A. B., & Son Co., New York.

BUOYS, LIGHT—See LIGHT BUOYS.

BUOYS, RING.
Ferdinand, L. W., & Co., Boston, Mass.

BURNERS, FUEL OIL—See FUEL OIL BURNERS.

BUSHINGS.
National Tube Co., Pittsburg, Pa.

BUTTERFLY VALVES—See VALVES.

BY-PASS VALVES—See VALVES.

CABLEWAYS—See MARINE CABLEWAYS.

CALORIMETERS—SEPARATING, THROTTLING, COAL.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Schutte & Körting Co., Philadelphia, Pa.

CANOE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

CANVAS—FOR LIGHTER COVERS, HATCH COVERS, TARPAULINS.
Bunker, E. A., New York.

CAPSTANS—STEAM—ELECTRIC—HAND.
American Ship Windlass Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

CARGO BLOCKS—See BLOCKS.

CASTINGS—BRONZE—Also see STEEL CASTINGS.
Griscom-Spencer Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.
Ruggles-Coles Engineering Co., New York.
Vanadium Metals Co., Pittsburg, Pa.

CAST-IRON VANADIUM.
American Vanadium Co., Pittsburg, Pa.

CAST-STEEL VANADIUM.
American Vanadium Co., Pittsburg, Pa.

CEMENT-ASBESTOS.
Johns-Manville, H. W., Co., New York.

CEMENT-LINOLEUM.
Ferdinand, L. W., & Co., Boston, Mass.

CENTRIFUGAL PUMPS—See PUMPS.

CHAIN PIPE WRENCHES—See WRENCHES.

CHAIN STOPPERS.
American Ship Windlass Co., Philadelphia, Pa.

CHANDLERY STORES.
Ferdinand, L. W., & Co., Boston, Mass.
Griscom-Spencer Co., New York.
Ostermoor & Co., New York.

CHECK VALVES—See VALVES.

CHRONOMETERS—See CLOCKS.

CHOCKS.
American Ship Windlass Co., Philadelphia, Pa.

CHUCKS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

CIRCULATING PUMPS—See PUMPS.

CIRCULATORS.
Ross Schofield Co., New York.

CLASSIFICATION ASSOCIATION.
American Bureau of Shipping, New York.

CLOCKS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston. Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Star Brass Mfg. Co., Boston, Mass.

CLOTH—FOR LIGHTER COVERS, HATCH COVERS AND TARPAULINS.
Bunker, E. A., New York.

COATINGS, ANTI-RUST—See ANTI-RUST COATINGS.

COCKS—See GAUGE COCKS.

COAL HANDLING MACHINERY.
Lidgerwood Mfg. Co., New York.

COLLECTORS—PNEUMATIC.
Sturtevant Co., B. F., Hyde Park, Mass.

COMPANION FLANGES.
Lunkenheimer Co., Cincinnati, Ohio.

COMPOUNDS—See BOILER COMPOUNDS.

CONDENSERS.
Davidson, M. T., Co., New York.
Griscom-Spencer Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., Carteret, N. J.
Williamson Bros. Co., Philadelphia, Pa.

CONSULTING ENGINEERS—See ENGINEERS—Also PROFESSIONAL CARDS.

CONVEYING MACHINERY.
Lidgerwood Mfg. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

COOLERS, AIR—See AIR COOLERS.

COOLERS FOR OIL.
Schutte & Körting Co., Philadelphia, Pa.

COPPER—See BRASS AND COPPER.

CORDAGE—Also see ROPE and WIRE ROPE—Also TWINE.
Columbian Rope Co., Auburn, N. Y.
Durable Wire Rope Co., Boston, Mass.
Griscom-Spencer Co., New York.
Plymouth Cordage Co., North Plymouth, Mass.

CORK CEMENT, FENDERS, JACKETS, RINGS.
Armstrong Cork Co., Pittsburg, Pa.
Ferdinand, L. W., & Co., Boston, Mass.

CORRUGATED FURNACES.
Continental Iron Works, Brooklyn, N. Y.

COTTON DUCK—See CHANDLERY STORES.

COTTON RUBBER-LINED HOSE—See HOSE.

COUNTERS—See REVOLUTION COUNTERS.

COVERING, STEAM—See NON-CONDUCTING COVERING.

CRANES.
Niles-Bement-Pond Co., New York.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N.Y.
Williamson Bros. Co., Philadelphia, Pa.

CRANK SHAFTS—See FORGINGS.

CUPRO-VANADIUM.
American Vanadium Co., Pittsburg, Pa.

CUTTERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., New York.

CYLINDER BORING BARS.
Niles-Bement-Pond Co., New York.

CYLINDER RELIEF VALVES—See VALVES.

CYLINDERS FOR COMPRESSED AIR, GAS, ETC.
National Tube Co., Pittsburg, Pa.

CYLINDERS, VANADIUM.
American Vanadium Co., Pittsburg, Pa.

DAVITS.
Welin Davit and Lane & DeGroot Co,. Consol., Long Island City, N.Y.

DECK HOISTS—See HOISTING ENGINES.

DECK PLATES.
Sands, A. B., & Son Co., New York.

DECK PUMPS—See PUMPS.

DIAPHRAGM PUMPS—See PUMPS.
Hyde Windlass Co., Bath, Maine.

DIES.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., New York.

DIRECT-CONNECTED SETS—See ELECTRICAL PLANTS.

DISENGAGING GEARS.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N.Y.

DISTILLERS—See EVAPORATORS.

DIVING APPARATUS.
Morse, Andrew J., & Son, Inc., Boston, Mass.

DRAFT, MECHANICAL—See MECHANICAL DRAFT.

DRAIN VALVES—See VALVES.

DRAWING PAPER.
Frey, Louis, & Co., New York.

DREDGING MACHINERY.
Williamson Bros. Co., Philadelphia, Pa.

DRILLING MACHINES, VERTICAL, HORIZONTAL AND RADIAL.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., New York.

DRILLS.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., New York.

DRILLS, ELECTRIC—See ELECTRIC DRILLS.

DRILLS, PNEUMATIC—See PNEUMATIC TOOLS—Also AIR DRILLS.

DRILLS, PORTABLE—See PORTABLE DRILLS.

DROP FORGINGS—EYE BOLTS, HOOKS, ROPE SOCKETS, WRENCHES, ETC.
Billings & Spencer Co., Hartford, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

DROP HAMMERS.
Billings & Spencer Co., Hartfod, Co.
Niles-Bement-Pond Co., New York,

DRY DOCKS AND MARINE RAILWAYS.
Merrill-Stevens Co., Jacksonville Fla.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Tietjen & Lang Dry Dock Co., Hoboken, N. J.

DRYING APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

DYNAMOS—See ELECTRIC PLANTS; also STEAM TURBINE DYNAMOS.

ECONOMIZERS, FUEL—See FUEL ECONOMIZERS.

EJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.

ELECTRIC DRILLS.
General Electric Co., Schenectady, N. Y.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

ELECTRIC HEATERS.
General Electric Co., Schenectady, N. Y.
Simplex Electric Heating Co., Cambridgeport, Mass.

ELECTRIC HOISTS.
American Ship Windlass Co., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Niles-Bement-Pond Co., New York.
Williamson Bros. Co., Philadelphia, Pa.

ELECTRIC LIGHTS.
General Electric Co., Schenectady, N. Y.

ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

ELECTRICAL FITTINGS AND SUPPLIES—Also see ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
Griscom-Spencer Co., New York.
Johns-Manville, H. W., Co., New York.

ELECTRICAL INSTRUMENTS.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J

ELEVATORS, FREIGHT—See FREIGHT ELEVATORS, also INCLINED ELEVATORS.

ENGINE PACKING—See PACKING.

ENGINE-ROOM SUPPLIES—See STEAM SPECIALTIES.

ENGINEERS, CONSULTING AND CONTRACTORS.
Donnelly, W. T., New York.
Griscom-Spencer Co., New York.
Williamson Bros. Co., Philadelphia, Pa.

ENGINES FOR AUXILIARIES.
American Blower Co., Detroit, Mich.
American Ship Windlass Co., Philadelphia, Pa.
De Laval Steam Turbine Co., Trenton, N. J.
Hyde Windlass Co., Bath, Maine.
Kerr Turbine Co., Wellsville, N. Y.
Marine Iron Works, Chicago, Ill.
New London Ship & Engine Co., Groton, Conn.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Wheeler Condenser and Engineering Co., Carteret, N. J.

ENGINES, GASOLINE—See GASOLINE ENGINES.

ENGINES, HOISTING—See HOISTING ENGINES.

ENGINES, KEROSENE—See KEROSENE ENGINES.

ENGINES—OIL.
Mietz, A., New York.
New London Ship & Engine Co., Groton, Conn.

ENGINES—PROPELLING.
Bath Iron Works, Bath, Maine.
Kingsford Foundry & Machine Works, Oswego N. Y.
Marine Iron Works, Chicago, Ill.
Mietz, A., New York.
New London Ship & Engine Co., Groton, Conn.
Parsons Marine Steam Turbine Co., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.
Trout, H. G., Co., Buffalo, N. Y.
Ward, Chas., Engineering Works, Charleston, W. Va.

ENGINE REGISTERS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

ENGINE-ROOM CLOCKS—See CLOCKS.

ESCALATORS.
Otis Elevator Co., New York.

EVAPORATORS.
Davidson, M. T., Co., New York.
Griscom-Spencer Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., Carteret, N. J.
Williamson Bros. Co., Philadelphia, Pa.

EXCESS PUMP GOVERNORS—See PUMP GOVERNORS.

EXHAUST FANS—See BLOWERS.

EXHAUST HEADS.
Sturtevant Co., B. F., Hyde Park, Mass.

EXPANDERS—See BOILER FLUE AND TUBE EXPANDERS.

EXPANSION JOINTS.
Griscom-Spencer Co., New York.
National Tube Co., Pittsburg, Pa.
Power Specialty Co., New York.

FANS—See BLOWERS.

FEED CHECK VALVES—See VALVES.

FEED-WATER HEATERS AND PURIFIERS.
Griscom-Spencer Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., Carteret, N. J.
Williamson Bros. Co., Philadelphia, Pa.

FEED-WATER REGULATORS.
Jerguson Gage & Valve Co., Boston, Mass.

FERRO-VANADIUM.
American Vanadium Co., Pittsburg, Pa.

FERRY BOAT LAMPS—See LAMPS.

FILES.
Nicholson File Co., Providence, R. I.

FILTERS.
Griscom-Spencer Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

FIRE DEPARTMENT SUPPLIES.
Hayward, S. F., & Co., New York.
Morse, Andrew J., & Son, Inc., Boston, Mass.

FIRE EXTINGUISHERS.
Hayward, S. F., & Co., New York.
Morse, Andrew J., & Son, Inc., Boston, Mass.

FIRE HOSE—See HOSE.

FIREPROOF CONSTRUCTION.
Johns-Manville, H. W., Co., New York.

FIREPROOF LUMBER—See LUMBER, FIREPROOF.

FIRE PUMPS—See PUMPS.

FLANGES.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.

FLANGING PRESSES.
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

FLEXIBLE SHAFTING.
Stow Mfg. Co., Binghamton, N. Y.

FLOATING DRY DOCKS—See DRY DOCKS.

FLUE CLEANERS—See BOILER FLUE CLEANERS.

FLUE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

FORCED DRAFT—See also BLOWERS.
American Blower Co. and Sirocco Engineering Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

FORGES.
Sturtevant Co., B. F., Hyde Park, Mass.

FORGINGS, BRONZE—See also DROP FORGINGS.
Erie Forge Co., Erie, Pa.
Hyde Windlass Co., Bath, Me.
Vanadium Metals Co., Pittsburg, Pa.

FORGINGS, OPEN HEARTH STEEL.
Erie Forge Co., Erie, Pa.

FORGINGS, VANADIUM.
American Vanadium Co., Pittsburg, Pa.

FREIGHT ELEVATORS FOR DOCKS AND WHARVES.
Otis Elevator Co., New York.

FROSTPROOF COVERINGS.
Ferdinand, L. W., & Co., Boston, Mass.

FUEL ECONOMIZERS.
Griscom-Spencer Co., New York.
Power Specialty Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

FUEL OIL BURNERS.
Schutte & Körting Co., Philadelphia, Pa.

FURNACES—Also see CORRUGATED FURNACES.
Continental Iron Works, New York.

FUSIBLE PLUGS.
Griscom-Spencer Co., New York.

GALLEYS—See RANGES.

GAS BLOWERS AND EXHAUSTERS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

GASKETS—Also see PACKING.
Crandall Packing Co., Palmyra, N. Y.
Griscom-Spencer Co., New York.
Johns-Manville, H. W., Co., New York.
Katzenstein & Co., L., New York.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., New York.
Power Specialty Co., New York.
Smooth-On Mfg. Co., Jersey City, N. J.
Vanda Co., New York.

GASOLINE ENGINES—Also see LAUNCHES AND YACHTS; also KEROSENE ENGINES—Also OIL ENGINES.
Bridgeport Motor Co., Bridgeport, Conn.
Buffalo Gasoline Motor Co., Buffalo, N. Y.
Mietz, A., New York.
Standard Motor Construction Co., Jersey City, N. J.

GAS ENGINE SPECIALTIES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

GAS PRODUCERS—See MARINE GAS PRODUCERS

GATE VALVES—See VALVES.

GAUGE COCKS.
American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio
Star Brass Mfg. Co., Boston, Mass.

GAUGES—See STEAM GAUGES.

INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Powell Co., The, Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

INTERLOCKING RUBBER TILING.
Griscom-Spencer Co., New York.
New York Belting & Packing Co., Ltd., New York.

IRON CEMENT.
Smooth-On Mfg. Co., Jersey City, N. J.

JACKS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

JACKS FOR UNCOUPLING SHAFTS.
Watson-Stillman Co., New York.

JOURNAL BEARINGS—See THRUST BEARINGS.

JUTE.
Columbian Rope Co., Auburn and New York.

KEROSENE ENGINES.
Mietz, A., New York.

LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.

LAMPS, SIGNALS, AND FIXTURES.
Carlisle & Finch Co., Cincinnati, Ohio.
General Electric Co., Schenectady, N. Y.
Johns-Manville, H. W., Co., New York.

LATHES, ENGINE.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., New York.

LATHES, TURRET.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., New York.

LAUNCHES AND YACHTS—See also SHIPBUILDERS AND DRY DOCK COMPANIES.
Bridgeport Motor Co., Bridgeport, Conn.
Buffalo Gasolene Motor Co., Buffalo, N. Y.
Marine Iron Works, Chicago, Ill.
Standard Motor Construction Co., Jersey City, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N.Y.

LAVATORIES—FOLDING, STATIONARY, STATEROOM.
Sands, A. B., & Son Co., New York.

LAVATORY AND BATH HEATERS.
Griscom-Spencer Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

LIFE BOATS AND RAFTS.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N.Y.

LIFE GUNS.
Hayward, S. F., & Co., New York.

LIFE PRESERVERS.
Armstrong Cork Co., Pittsburg, Pa.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N.Y.

LIFE-SAVING DEVICES.
Hayward, S. F., & Co., New York.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N.Y.

LIGHTS.
American Gasaccumulator Co., Philadelphia, Pa.

LIGHT BUOYS.
American Gasaccumulator Co., Philadelphia, Pa.

LIGHTHOUSE APPARATUS.
American Gasaccumulator Co., Philadelphia, Pa.

LINOLEUM CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

LIQUID GLUE, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

LOG REGISTERS.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.
Welin Davit and Lane & DeGroot Co., Consol., Long Island City, N.Y.

LUBRICANTS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.
International Acheson Graphite Co., Niagara Falls, N. Y.
Power Specialty Co., New York.

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Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
International Acheson Graphite Co., Niagara Falls, N. Y.

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Cook's Sons, Adam, New York.
Griscom-Spencer Co., New York.
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McNab & Harlin Mfg. Co., New York.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

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MANGANESE BRONZE CASTINGS—Also see BRONZE.
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Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.
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Lidgerwood Mfg. Co., New York.

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Marine Producer Gas Power Co., New York.

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General Electric Co., Schenectady, N. Y.
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American Ship Windlass Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
Williamson Bros. Co., Philadelphia, Pa.

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General Electric Co., Schenectady, N. Y.

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Schutte & Körting Co., Philadelphia, Pa.

OILDAG.
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Star Brass Mfg. Co., Boston, Mass.

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